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Protective-Relay Applications and Testing Practice

Current Relays With Selective Time Setting Used on Radial Systems—Ring and Parallel-Feeder Systems Require Directional Relays — Special Connections Necessary for Machinery Protection

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The function of a protective relay is to confine an electrical disturbance to the element in which it occurs and to limit the amount of local trouble insofar as may be possible, usually by removing the applied potential. Almost any case of trouble on a transmission system or its connected apparatus can be handled by the proper application of modern current and directional relays, using standard methods of connections. As the art of relay application is a rapidly advancing one, it is frequently interesting and profitable to review the modern up-to-date methods of protection which may be called standard.

One of the most important applications of protective relays is in the protection of transmission systems. Here the particular duty of the relay is to disconnect a faulty section of line, thus preventing a general disturbance of the entire system and the consequent loss of load. This is a most important application, for, as all operating men will testify, power customers complain most bitterly of any loss of power supply. With many consumers even the momentary failure of power means the loss of much time and money. Hence it becomes most important that systems be so laid out, and protective devices so applied, that no contingency short of a real emergency shall be able to cut off any station from its power source. It should be carefully noted, however, that the primary step in system protection is system design. No scheme of relay protection, however ingenious, can overcome the handicap imposed by an improperly laid out network.

Radial Feeder System Protected by Current Relays.

The simplest scheme of system protection is that of a radial system as shown in an accompanying illustration. Here all lines radiate from the power source like the spokes of a wheel and are sectionalized at various points, either for convenience in power distribution or for additional protection in the case of long lines. Current relays only are used for such a system, and are applied to the transmitting end of each section and timed successively with increasing increments of time from the most remote section to the power source. By current relays are meant

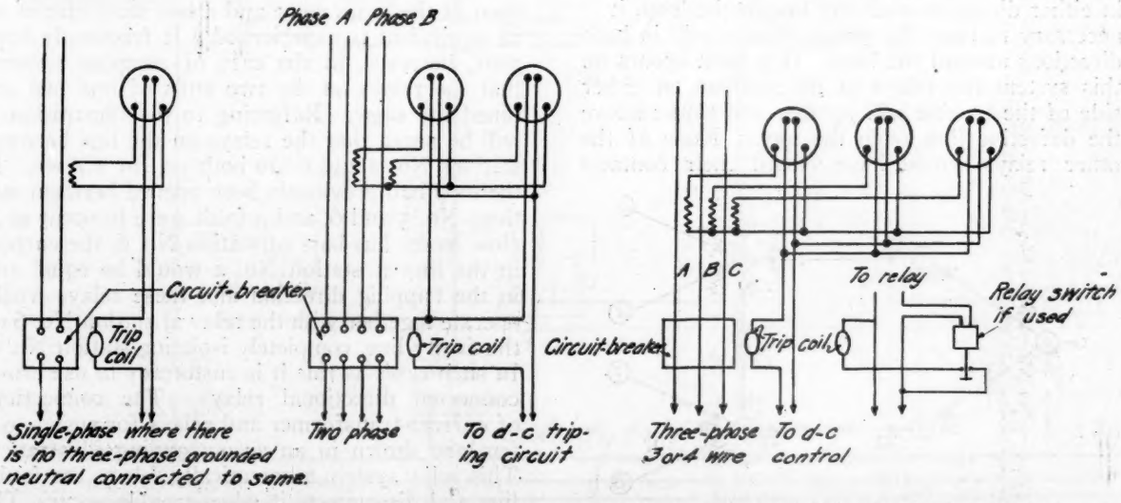


Diagram of Connections for Current Relays Used on One, Two and Three-Phase Lines.

over-current inverse-time-limit relays unless otherwise stated. No directional relays are used for, since there are no parallel lines or interconnected stations, it is impossible to have a reversal

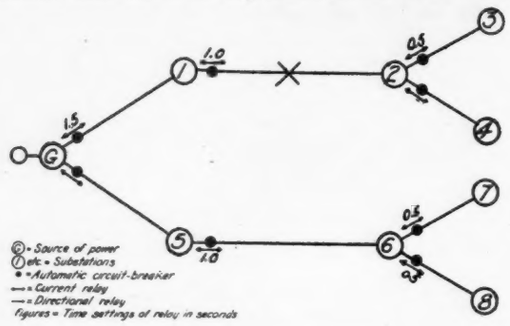
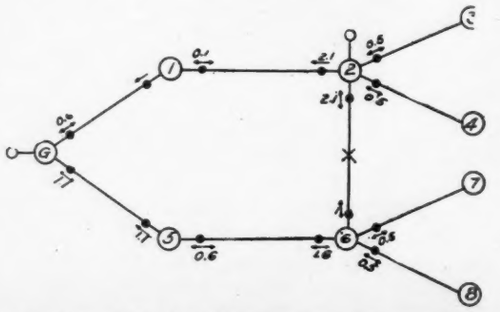

Ⓖ = Source of power
① etc. = Substations
● = Automatic circuit-breaker
—○— = Current relay
—→— = Directional relay
figures = Time settings of relay in seconds

Diagram of a Radial Distribution System, Showing Use of Current Relays.

of power flow. A fault at *X* will cause the current relay at station No. 1 to operate and disconnect the line between stations No. 1 and 2 and hence remove the defective section from the system. As all stations fed from station No. 2 are also disconnected, this is not a satisfactory layout and is seldom used. However, as individual radial feeders are found in every system, this scheme cannot be neglected. The connections for the current relays are shown in an accompanying illustration. The disadvantages of the radial system can be overcome by the use of parallel feeders, by interconnecting the substations or by a combination of both.

In a parallel system the feeders are protected by current relays at the transmitting end and directional relays at the receiving end of the line. In such a system a fault on any line will draw reverse power from its parallel feeders and so instantaneously disconnect one end. The current relay on the other end will then operate and thus sectionalize the defective line. A single-line system with interconnected substations is shown in an accompanying illustration. This is a similar system to the one already described, but with stations No. 2 and 6 interconnected. This type of system is ordinarily protected by applying directional relays at both ends of all lines in the loop, except at the power station. As power can flow in either direction over any line in the loop, it is necessary to time the relays successively in both directions around the loop. If a fault occurs on this system the relays at the stations on either side of the trouble will operate and thus remove the defective line from the loop. None of the other relays would have closed their contacts



Ring System of Feeders With Source of Power Charged to Station No. 2.

owing to their selective time settings, and no station would have been cut off from its power supply.

It is interesting to note that as long as there is a power supply at station *G* the scheme of protection can be modified by using one set of current relays at each substation in place of the higher timed directional relays without affecting the scheme. This is very desirable as it saves space and additional wiring and requires fewer potential transformers. This protection is equal to that obtained where all substations use directional relays as long as power is fed into the system at station *G*. If, however, the source of power fails at station *G* and is supplied by station No. 2 it is not possible to protect the system by changing the time settings on the various relays. Now a fault at *X*, between stations No. 2 and 6, would operate the current relay at station No. 6 set at 1 sec. and also the current relay at station No. 1 set for 0.1 sec. and isolate every substation on the loop. Hence, if current relays are used on such a system in conjunction with directional relays, an accurate knowledge of the system is necessary to guarantee the safety of their application.

Parallel Lines and Interconnected Stations Used in Modern Systems.

A modern system combines the parallel lines and the interconnected stations, giving a network such as that shown in an accompanying diagram. Such a system has the advantage of both these schemes, and it is impossible for any station to

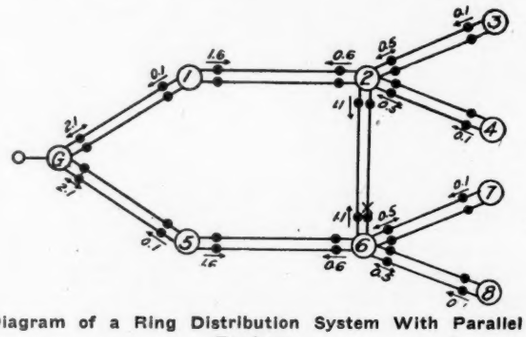
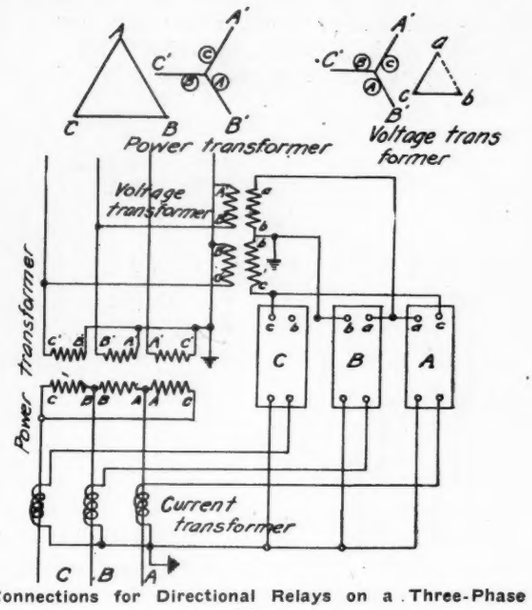


Diagram of a Ring Distribution System With Parallel Feeders.

become isolated unless both lines of the loop are open at the same point and a bus short-circuit or its equivalent is experienced. It frequently happens, however, in the case of complex systems that the relays on the two ends of one line are timed the same. Referring to the illustration it will be noted that the relays on the line between stations No. 2 and 6 are both set for 1.1 sec. If the loop had previously been opened between stations No. 5 and 6, and a fault were to occur at *X* close to the bus-bars of station No. 6, the current in the line at station No. 2 would be equal and in the tripping direction and these relays would operate together with the relay at station No. 6 on the faulty line, completely isolating station No. 6. In such cases as this it is customary to use cross-connected directional relays. The connections of current transformer and relays for sush a system are shown in an accompanying illustration. This relay system automatically selects the faulty line and disconnects it when trouble occurs. The cross connection finds its chief application on tie

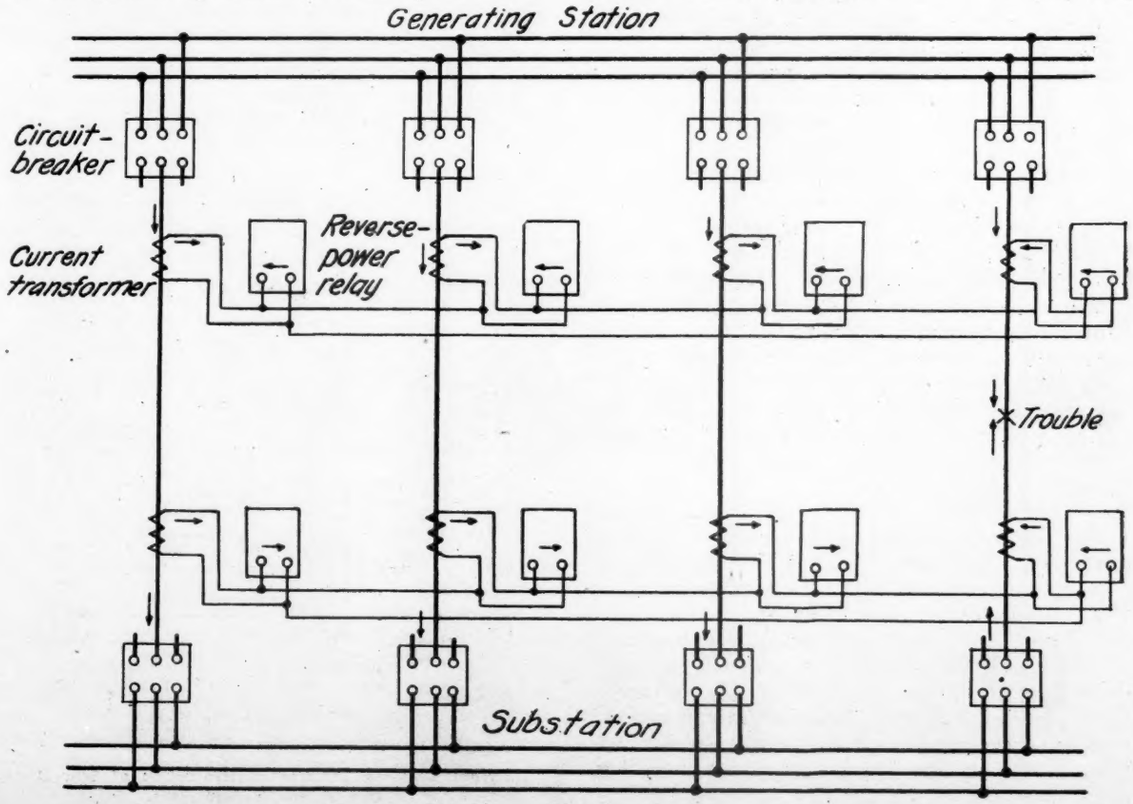
lines between generating stations and on loops wherein the various stations are connected by parallel lines and power is fed in at more than one point. In such systems it is desirable that the various generating stations shall not become separated because of the trouble which will be experienced when it is attempted to reunite the loop. The use of balanced relays is one of the most desirable means of securing discriminating protection under these circumstances. The cross connection also finds an application on systems which are so complex that selective timing becomes impossible. The advantages of the cross connection are that it can be applied to any system having parallel feeders, it is instantaneous in operation, and it can be made to operate on small unbalances of power such as are caused by high-resistance grounds. Its chief disadvantages are lack of bus protection and trouble in cutting in new lines which may cause the lines already in service to be disconnected on account of unbalanced power. Hence, cross-connected relays offer disadvantages that are not encountered with standard connections, but offer the solution of many difficult problems of protection.



Connections for Directional Relays on a Three-Phase Line.

Protection Against Grounds Depends on Design of System.

Ground protection of transmission lines is taken care of by the line relays on a system that is solidly grounded, but, if the system is ungrounded or grounded through a limiting resistance, it is necessary to provide additional protection to take care of line grounds. This is ordinarily done by inserting a relay in the neutral connection of the line relays which is operated by the unbalanced current in the neutral wire when the line becomes grounded. This may be a current relay set to operate on a low value of current, as in the case of a system grounded through a low resistance. In case the system is grounded through a fairly high resistance or is ungrounded a watt relay is used, the potential coil being energized by the drop in voltage across a resistance inserted in the neutral of the potential transformers. The current relay is set to trip at a low value, usually 1 ampere or less. The connections to the standard current relays are not affected, nor is their operation. The relay has a time element, and selective operation can be affected between successive sections of line. The watt relay



Schematic Diagram of Cross-Connected Relays, Showing Current-Transformer Circuits for One Phase.

is more sensitive to small currents in the neutral wire than is the current relay, due to the presence of the potential coil. As this coil is energized by the drop of voltage due to the current in the re-

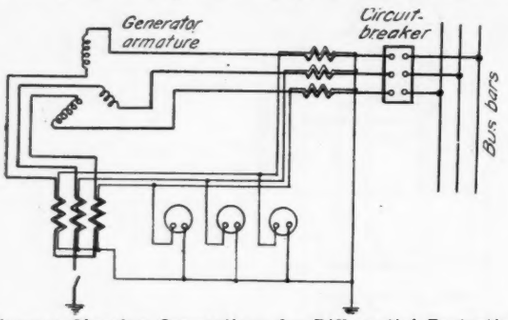


Diagram Showing Connections for Differential Protection of Generators.

sistance, its flux is in phase with that of the current coil and consequently the relay has high torque. This relay also has an adjustable time element for selective action.

Protection of Station Equipment Requires Special Attention.

Generators may be protected by current relays, directional relays or differentially connected current relays, the choice depending upon the size and layout of the system and the design of the machines. Current relays require a long time setting and may permit excessive injury to a generator in case of an internal fault. Directional relays can be set for a shorter time, but may operate due to circulating current when synchronizing. Probably the most satisfactory method of protection, and the one most commonly used today when possible, is that of differential protection. This requires that the neutral lead of each phase be brought out of the machine. A current transformer is connected on either side of each phase winding and the secondaries are connected in series. The current relay is connected across the transformers, as shown in the illustration. Under all load conditions current circulates through the transformer secondaries and does not enter the winding of the high-impedance relay. An internal fault, however, will cause the transformer near the bus to draw a heavy current. The unbalanced current will flow through the relay which will operate to disconnect the machine from the system. Since the relays can be set to operate instantaneously, this scheme gives maximum protection.

Power transformers are commonly protected by the same differential method of protection as described in connection with generators. Current-transformer ratios are chosen so that the secondary currents are equal, and load conditions will affect both equally without current entering the relay. But when trouble develops in the windings the unbalanced current will operate the relay and disconnect the power transformer from the line. This scheme can be applied to transformer banks which are connected star-star, delta-delta, delta-star, star-delta, or two phase-three phase. It is only necessary to connect the current transformers so that the resulting opposing currents are equal in value and 180 deg. apart in phase.

Rotary converters are ordinarily protected by means of current and low-voltage relays on the a-c. side, reverse-current relays on the d-c. side, and an over-speed device. The current relay performs its usual function, and the low-voltage relay disconnects the machine from the line in case of failure of the a-c. potential. The over-speed device on the armature is an ultimate protection in case of failure of the relays.

The proper method of protecting synchronous condensers is a question on which opinions vary. The operating conditions of this machine are peculiar in that it is desirable to keep it on the line under all system conditions and yet be able to protect it from internal faults. The condenser must also be protected from severe overloads, but must be capable of carrying a high overload for short periods of time or until overheated. Protection can be best secured by a combination of current and temperature relays. The current relay is frequently set for a long time on overloads of the nature of 200 to 400%, but provided with an instantaneous attachment which will operate on 500% load. Thus the line relays will remove defective feeders from the bus before the long-time relay on the condenser can operate. But in the case of a short-circuit in the condenser or on its leads the instantaneous attachment will operate to protect the condenser. The temperature relay, which is controlled by exploring coils in the stator slots, allows the machine to carry a reasonable overload for a considerable length of time until the temperature of the machine has reached a dangerous value. It then operates to warn the operator by means of an alarm, or it automatically operates the voltage regulator on the system to relieve the condenser.

Relays Must Be Tested to Assure Reliability in Service.

Importance of thorough and frequent testing and inspection of protective relays cannot be overemphasized. Relays are a vital part of a system, and upon their proper operation depends the safety of a considerable financial investment as well as the continuity of service. The methods and schedule of tests vary with the different operating companies, but as the problem is a

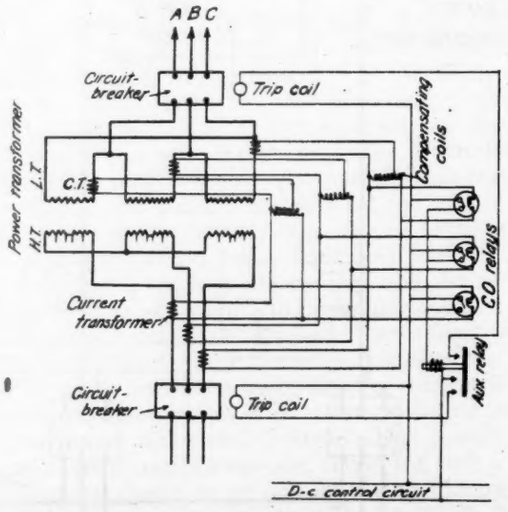


Diagram Showing Differential Protection of Star-Delta-Connected Transformers.

common one a few general recommendations can be made.

The frequency of making these tests is largely a matter of personal opinion, operating conditions and available resources. For instance, a relay which operates frequently should be inspected more often than one which is called upon to operate only at rare intervals. Likewise, a relay which is located in a dust-laden or gas-filled atmosphere is in need of more attention than one situated under more favorable conditions. In general, however, a thorough test of every relay should be made at least twice a year, these tests including a check of calibration and insulation.

The ideal method of calibrating a relay and testing all connections at the same time is to apply load to the primary circuit of the current transformer. Such a procedure tests all circuits and connected units. As this method is usually impractical it is customary to make use of another method. This does not disturb any wiring whatever, and tests the continuity of all circuits and the condition of the current-transformer secondary. Some type of automatic chronometer such as a cycle counter should always be used to check the time curve, as a stop watch is inadequate.

Frequent Tests Made of Circuits and Mechanical Operation.

Even more important than the semiyearly tests are the frequent inspection tests made at regular periods. It is these tests that bring to light the ordinary ills of relays. Such tests are made by some operating companies as often as once a week, the average being about once a month. In making these tests special attention should be placed on the removal of dirt, cleaning and aligning of contacts and the proper operating condition of the moving element. This last is particularly important, especially in the case of induction relays which have a disk rotating in the small air gap of a permanent magnet. Blowing out these relays may cause magnetic dirt to lodge in the air gap and destroy the calibration of the relay. This can be removed with a piece of iron wire. Condition of the trip circuit should be checked by manually operating the relay contacts. As this is an important matter it is the custom of many companies to make the checking of this circuit a matter of daily routine. Thus, once during the day, at a time when the line is to be removed from service, or when it can be taken out without disturbing the system, the operator will open up the relay and close the contacts by hand. This tests all parts of the tripping circuit. Some companies consider the point so important that they provide a permanent indication of the integrity of the tripping circuit by connecting a lamp permanently across the relay contacts. As long as the lamp is lit the operator knows that the tripping circuit is intact. When the relay is operated the contacts short-circuit the lamp, and the additional current in the trip coil is sufficient to cause it to operate.

Details of Relay Connections Should Be Checked at Time of Installation.

Frequent cases of trouble on directional relays are traceable to wrong voltage connections resulting in a wrong phase angle between the current and voltage fluxes in the relay. This matter can be simply checked, and should always be checked when relays are first installed, by applying a single-phase power-factor meter to the relay connections or by inserting a single-phase wattmeter in the relay circuit. At 100% power-factor on the line the current in the relay should lead the voltage by 30 deg. This can be read directly on the power-factor meter and the proper voltage leads chosen. Or the same result can be obtained by choosing the pair of voltage leads which gives a maximum reading on the single-phase wattmeter when the load power-factor is lagging.

The complete connections of any balanced system of relay protection can be tested by short-circuiting the secondary of either one of any pair of balanced current transformers and opening the line outside of the short-circuit. This produces a severe unbalance, and the unbalanced current operates the relay and trips the circuit-breaker, thus testing all related circuits. This should be repeated by successively short-circuiting the secondary of each of the current transformers. The timing of the opening of circuit-breakers should also be checked periodically. Proper adjustment of a circuit-breaker to cause it to open in a predetermined time is a matter of importance both for the protection of the breaker itself and for the proper co-operation of its action with that of the relay which actuates it. This is particularly true on a system where the relays are set with minimum allowable differences in time setting.

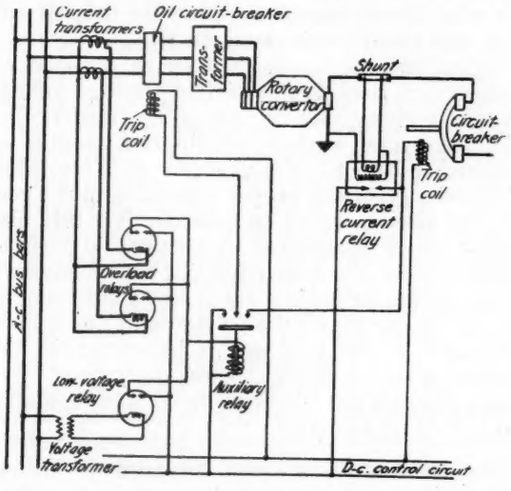


Diagram of Relay Protection for Rotary Converters.

Some operating companies prefer to test the operation of their relays by duplicating actual service conditions. This is done either by imposing an actual short-circuit on the system or by simulating short-circuit conditions by the manipulation of connected apparatus.

FRANKLIN INSTITUTE AWARDS GOLD MEDAL TO DR. EMMET.

The Franklin Institute of the state of Pennsylvania, Philadelphia, acting through its committee on science and arts, has awarded to Dr. W. L. R. Emmet, Schenectady, N. Y., its Elliott Cresson gold medal in recognition of his notable contributions to the art of ship propulsion.

Voltage Control of Long-Distance Transmission Lines

Tenth of a Series* of Articles Giving a Review of the Electric Power Situation—Use of Line-Drop Compensators—Effect of Electrostatic Capacity—Voltage Regulation of Feeders—Influence of Power-Factor

By ALFRED STILL

Voltage control and power-factor control on alternating-current circuits are closely allied subjects, but in this article it is proposed to consider voltage regulation and control, avoiding unnecessary reference to power-factor control, which will be discussed in a subsequent article.

When the bus-bar pressure is maintained constant at the generating station the pressure available at the distant end of a transmission line will vary with the load, and if there are several feeders of different lengths the pressure drop at full load will rarely be the same on all.

By raising the bus-bar voltage as the load increases it is possible to maintain constant voltage at the receiving end of one of the feeders, but not on several feeders of different lengths or differently loaded. If each feeder were connected to its own generator proper regulation in the generating station would be possible, but this plan would not be economical. Sometimes a group of short feeders is connected to one set of bus-bars, while the longer feeders are grouped onto another set of bus-bars, and the voltage will not then be the same on the two sets of bus-bars; but this method also has fairly obvious objections. It is generally necessary to provide voltage regulation on individual feeders.

Voltage Regulation on Station Bus-Bars.

The voltage regulation in the power station may be done by hand or by means of automatic regulators. In this country the Tirrill automatic regulator is much used and has proved very satisfactory, while in Europe the Thury regulators appear to be favored.

In the Tirrill regulator a system of relays and contact-making devices automatically cuts out the whole or a portion of the field rheostat when the voltage falls below the lower limit for which the apparatus is set. This causes a momentary increase of the field strength which is checked as soon as the voltage reaches the predetermined upper limit. The action is rapid, and, under normal operating conditions, the contact-making device moves so quickly that it appears to be simply vibrating between the open and closed positions. By this means an almost constant voltage is maintained at the bus-bars. The arcing at the contacts is practically eliminated by shunting the exciter rheostat with a condenser of suitable capacity.

In the Thury regulator an independent motor actuates the multiple-contact switch of the generator field rheostat, cutting in and out resistance as the switch arm is moved in one direction or the other. The direction of motion is controlled by means of an electromagnetic balance through a rocking arm suitably connected by tappets and pawls to the wheel which operates the regulating switch. The action of this regulator is not quite so rapid as the Tirrill regulator, but it is sufficiently fast to give good service. The switch arm usually can travel over the complete range from maximum to minimum shunt resistance in about a quarter of a minute. The Thury regulator does not depend upon electrical make-and-break contacts used in the Tirrill regulator.

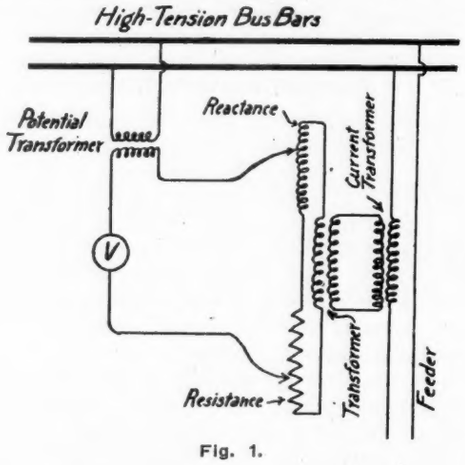


Fig. 1.

Use of Line-Drop Compensators.

It is not always necessary to maintain voltage at a constant value on the bus-bars in the generating station. Whether hand or automatic regulation is used, it is always possible to so adjust the pressure at the generating end of a transmission line that it shall remain constant at the distant end of the line where the energy is delivered. Obviously, if two or more feeders are connected to common bus-bars and the line drop is not the same in all, the best that can be done with bus-bar voltage regulation is to aim at maintaining a pressure which will best suit the average of the group of feeders.

The function of a line-drop compensator is to provide resistance and reactance in the potential leads to the voltmeter or to the regulator relay coils which will so reduce the voltage as to correspond with the pressure at the receiving end of the line in connection with which the device is to be used. In this manner a voltmeter in the gen-

*Preceding articles in this series appeared in the July 17, Aug. 7, Aug. 21, Sept. 4, Sept. 18, Oct. 2, Oct. 16, Nov. 6 and Nov. 20 issues of Electrical Review.

erating station may be made to indicate the voltage at the distant end of a long line without the necessity of bringing pilot wires all the way back from the place where it is desired to know the line pressure.

The voltmeter, as seen in Fig. 1, is not connected directly across the terminal of the potential transformer, but in series with a resistance and reactance which are so connected and may be so adjusted that they will reduce the reading on the voltmeter by an amount depending upon the current and proportional to the impedance drop in the feeder. The diagram is self-explanatory.

Effect of Electrostatic Capacity on Line Regulation.

In the diagram, Fig. 2, the pressure at the receiving end of the line is represented by the vector *OB*, while *OA*, drawn at right angles to *OB*—in the forward direction—is the capacity current. It

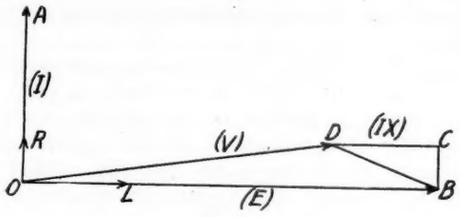


Fig. 2.

is assumed that the load is entirely disconnected and the current *I* is the total current on the line. The voltage component required at the generating end to overcome the ohmic resistance is *OR*, or *BC*, in phase with *I*, and the component required to balance the e.m.f. of self-induction is *CD*, drawn 90 deg. in advance of *OA*. The pressure required at generating end is *OD*, which may be smaller than *OB*. It is true that the capacity has been assumed to be concentrated at the receiving end of the line; but with distributed capacity the same effect of a rise in pressure as the distance from generating end increases will occur. It will be seen that this is due to the e.m.f. of self-induction of the charging current being in phase with the impressed voltage. If the lines were without inductance there could be no pressure rise.

The effect of capacity on the line when the distant end is closed on the load will depend upon the amount and nature of the load. If the load is heavy and largely inductive, the current put into the line at the generating end will be less than the load current, and the I^2R losses will therefore be smaller than if the line were without capacity.

It is because of this peculiar effect of capacity on transmission-line voltage that a distinction must be made between the terms "line regulation" and "line drop."

The percentage drop of pressure on a transmission line may be defined as the difference between the sending-end and receiving-end pressures expressed as a percentage of the receiving-end pressure. Thus,

$$\text{Percentage pressure drop} = \frac{V - E}{E} \times 100,$$

and this is the same as the regulation when the capacity current is so small as to be negligible. When the capacity current is appreciable it will cause the voltage of the unloaded line to be greater at the receiving than at the generating end, and since the regulation is defined as the change of pressure at the receiving end when the load is thrown off (the supply voltage remaining constant), the regulation of a long high-voltage transmission line will usually be greater than the pressure drop.

The pressure rise at the end of a long unloaded overhead transmission line does not depend upon the size or spacing of the wires. It may be calculated by means of the following formula:

$$\text{Percentage pressure rise due to capacity and inductance of overhead line} = 1.14\, f^2L^2 \times 10^{-7}$$

where L is the length of the line in miles. The percentage regulation of a transmission line, on the sine wave assumption, is therefore equal to *percentage line drop* $+ 1.14\, f^2L^2 \times 10^{-7}$, but the last term is negligible unless the distance of transmission L is great. The formula takes no account of the ohmic resistance of the line, but its effect is usually negligible.

Voltage Regulation on Feeders.

When a number of circuits are all supplied from the same generator or group of generators feeding into a common set of station bus-bars, the pressures at the distant ends of the circuits may be very different unless independent regulation of each individual circuit is provided.

The best place to install apparatus for maintaining constant voltage is usually where constant pressure is required, although it is quite feasible to provide feeder regulators at the generating station end of the line. Fig. 3 shows a transformer connected as a voltage "booster" on a single-phase circuit. The winding with relatively few turns is connected in series with the feeder while the other winding is connected as a shunt across the two conductors. The added voltage will therefore be proportional to the line voltage at the receiving end and practically independent of the current or load. Since the drop in the feeder increases with the load, it is usually desirable to add more volts at times of heavy load than at light load, and this may be done by providing tappings on the transformer coils and connecting these to a switch whereby the transforming ratio of the apparatus may be varied. In order to subtract instead of add volts to the line pressure, it is merely necessary to reverse the connections of one of the transformer windings. The dial switch used for cutting in or out sections of the winding may be operated by hand or automatically. It must be so constructed that sections of the winding are not short-circuited when the switch arm moves from contact to contact, neither must a break in the circuit occur. The construction of such a switch is somewhat similar to that of the switches used for varying the number of end cells in a storage battery. The automatic regulation may be with the Thury or Tirrill regulator.

Induction Type of Feeder Regulator.

Regulators with switch control are not usually desirable on high-pressure circuits. The induction regulator has the advantage that the second-

ary voltage is varied not by cutting in or out sections of the windings but by changing the amount of magnetic flux which links with the secondary circuit of a transformer provided with a movable iron core. If the secondary winding is placed in

Fig. 3.

the slots of a laminated cylindrical iron core similar to the armature core of an induction motor, and if the primary winding is in the slots of a ring core surrounding the secondary windings, it will readily be seen that an angular displacement of the one core relative to the other will cause the flux linking with the primary to inclose more or fewer of the secondary turns, with the result that the voltage induced in the secondary winding will be varied. This is the principle on which induction regulators are constructed. They are made for use on single-phase or polyphase circuits, being cooled by air, oil or circulating water, depending upon their output and other factors of design.

Induction regulators have recently been built in very large sizes. As an example, the Philadelphia Electric Co. desired to provide 9% regulation on its three-phase transmission lines between Philadelphia and Chester, Pa. The line pressure is 13,200 volts with a frequency of 60 cycles, the maximum line current being 830 amperes. The regulator must provide about 1200 volts at its secondary terminals, and the required output is therefore $\sqrt{3} \times 1200 \times 830 \times 10^{-3} =$ 1720 kv-a. These regulators, as actually constructed, are oil-cooled and arranged for outdoor operation, the motor and gear for rotating the movable core being protected from the weather by suitable iron covers.

Effect of Boosting Voltage at Intermediate Points on a Transmission Line.

If a long transmission line, insulated for a maximum working pressure of, say, 100,000 volts, can be operated as a 100,000-volt line at all times through its entire length, it will be more efficient than if only a portion of it is working as a 100,000-volt transmission while portions farther from the generating end are working at, say, 80,000 volts. By installing boosters along the line to maintain the pressure at or near the maximum working value, whatever the load may be, economies may frequently be effected. It is true that the energy put into the line at intermediate points cannot be cheaper—and, indeed, is usually more costly—than the energy supplied to the line at the generating end; but the booster system allows of the pressure being kept up all along the line, thus effecting economy provided always that the losses in the boosters themselves, their maintenance, and the necessary allowances for interest and depreciation do not counter-balance the saving.

It is not proposed to discuss this matter further at present, because, by power-factor control, the same end may be attained as by inserting variable ratio transformers of the types which have been described. The important question of power-factor control will be taken up in a succeeding article. The reason why power-factor has an effect on the line drop will, however, be very briefly explained before concluding this article.

Effect of Power-Factor and Power-Factor Variation on Line Drop.

Let OB in Fig. 4 stand for the voltage E on the load at the receiving end of a long transmission line; then if OA is the load current I, the power delivered at the distant end of the line is $EI \cos\theta$ if the system is single-phase, or $\sqrt{3}EI \cos\theta$ if it is three-phase. The angle θ or BOA must be such that $\cos\theta$ is equal to the power-factor of the load. Assume these quantities to remain unchanged, but consider the effect upon the voltage V at the generating end of the line when the power-factor of the line is changed. This may be done by connecting condensers of over-excited synchronous machines across the line and thus varying the amount of the charging current.

In the first place, if the capacity current is ON (drawn at right angles, in advance, of OB), the total current in the line is OM and the necessary generating and voltage V is OD, obtained by adding to OB the resistance drop BC, and the inductive drop CD drawn respectively parallel to and at right angles to OM.

In the second place, if the capacity between the lines is increased so that the charging current component is ON', the total line current will be OM', and the necessary voltage at generating end will be OD', which is seen to be appreciably less than OD. The power-factor at the generating end is $\cos\phi$ in the first case and $\cos\phi'$ in the second case, but the chief reason for the line drop

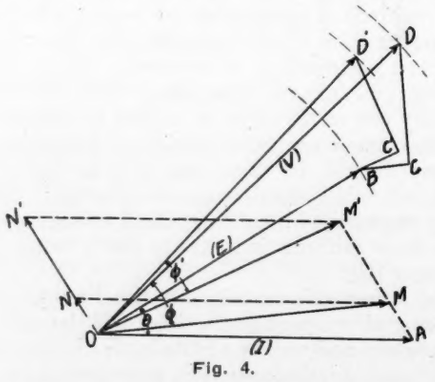


Fig. 4.

OD-OB of the small-capacity line being greater than OD'—OB of the large capacity line is the phase relation of the inductive drop (DC and $D'C'$) which causes this quantity to be of less importance in the second case than in the first. This suggests a means of controlling the voltage at the receiving end of a transmission line by purposely increasing the capacity between conductors and so causing the capacity current to control the pressure drop, not by appreciably reducing the amount of the inductive drop, but by altering its phase relatively to the load voltage in a manner suitable to the case.

This matter will be discussed further in a succeeding article which will deal mainly with power-factor control.

Central Stations for Radio Communication

Points of Similiarity Between Electric Power Engineering and Modern Radio Engineering Brought Out at Joint Meeting of Institute of Radio Engineers and New York Electrical Society

By E. F. W. ALEXANDERSON
Chief Engineer, Radio Corp. of America.

Wireless achievements are often referred to as belonging in the realm of mystery, and it is indeed remarkable that we are now able to speak with a voice that carries through empty space across the oceans. Whenever knowledge conquers a new force of nature for the use of humanity it ceases to be a mystery, but the pursuit of this knowledge makes an even greater appeal to the imagination.

The development of the steam engine was a triumph of the engineering art of the last century, but it was not the engine itself but the steamship and the locomotive that interested humanity. The telephone and telegraph cables, no less than the steam engine, have introduced a new era in human affairs. They have, to a degree, conquered space and time, but only with certain serious limitations.

Radio Communication Independent of Interception.

An ocean cable runs only from one landing place to another, and it can be cut in times of war; its use can be censored by its owners and controlled by military and naval power. When, on the other hand, you send a radio message it reaches all parts of the world. Depending upon whether it has been sent in code or in plain language, it may be a confidential private message or a press message intended for the world at large, but nobody can prevent the electromagnetic waves that carry the message from reaching their destination. It is thus not exaggeration to say that the emancipation of the human spirit that was begun by the invention of the printing press has found its fulfilment in radio communication. Radio makes the transmission of ideas from man to man and from nation to nation independent not only of any frail material carrier such as a wire, but above all it renders such communication independent of brute force that might be used to isolate one part of the world from another.

These are the ideal aims which inspire the engineers engaged in the development of the radio technique. This is also the explanation why some of the foremost lawyers, executives, financiers, officers and statesmen of this country have

View of Long Island, Showing How New York Radio Central Station of Radio Corp. of America Will Appear When Completed.

found incentive in the human aspects of the radio technique to devote a great deal of their time and thought to its promotion and development on a world-wide scale.

The interest evidenced by all concerned in this subject has become much more serious since it has been established that the laws and forces with which we are dealing are within the control of our knowledge, so that engineers can now proceed with the design of a radio-communication system with the same deliberate accuracy as in the design of an electric power transmission system from a waterfall to a railroad.

Similarity Between Radio and Electric Power Engineering.

The close connection which now exists between electric power engineering and modern radio engineering can be demonstrated to the conclusion that the development of the central station for radio communication is as logical and inevitable as was the development of the central electric power station. The entry of the corporation with which I have been connected for the last 20 years upon the field of radio communication has been a gradual growth and a natural consequence of its general activities in power engineering. The engineers specializing in alternating-current technique were in a natural position to take up the problem of designing the alternators and transformers needed in the radio technique. These differ from the ones used in the power technique principally in the fact that the number of alternations per second is about 1000 times as great. This speeding up of the performance 1000 times involved many new problems, but the most remarkable fact to record is that the generally established principles of the alternating-current power technique could be applied to the radio technique almost without change. It meant that the magnetic properties of iron which had been reduced to an exact science by Steinmetz 30 years ago had to be studied again at radio frequencies, but it was found that the Steinmetz laws of hysteresis, eddy currents and skin effect were as accurate at 200,000 cycles per second as at 25 cycles.

It was furthermore found that the established conceptions of phase displacement, power-factor, and leading and lagging currents were as applicable and useful in the high-frequency as in the low-frequency technique.

It is true that radically different methods had to be devised for measuring power-factors of a fraction of 1% from the methods used for measuring power-factors of 50 to 100%, but the new methods of investigation verified the well-known principles.

Problems of Generating Alternating Current for Radio Transmission.

The starting point of this development work was the time when Fessenden brought to the General Electric Co. the problem of generating alternating currents for radio transmission. In doing so Fessenden realized that a practical solution of this problem could be worked out only by an organization of specialists.

Some of the problems that presented themselves in the evolution of the radio power plant were: The design of a dynamoelectric machine or alternator generating electric power in the form of alternating currents of frequencies 1000 times as great as those used for motors and lamps; the development of magnetic amplifying devices capable of translating telephone and telegraph currents into corresponding modulations of the high-frequency energy flowing from the power plant into the radiating antenna; the development of a regulator so sensitive as to hold the speed of an ordinary induction motor constant within a few hundredths of 1%, this being necessary in order to maintain the proper phase relations in a load circuit working at one-third of 1% power-factor; improvement of the tuning of the antenna so as to transform as large a part as possible of the generated energy into electromagnetic waves.

The realization of Fessenden's vision, the radio power plant of today, became thus the result of the combined effort of leading electrical and mechanical engineers. Among these, it is sufficient to mention W. L. R. Emmet, the creator of the giant electric power stations of today. The radio power plant which resulted from this was shown to Marconi during a visit to Schenectady, and because of his interest in its performance it was transferred to the Marconi radio station in New Brunswick.

Here we had arrived at a point where two schools of engineering pursuing different aims with widely different modes of thought had been brought before a common problem. The one had been thinking in terms of power-factor kilowatts and phase displacement, and the other in terms of wave-length decrements and tuning.

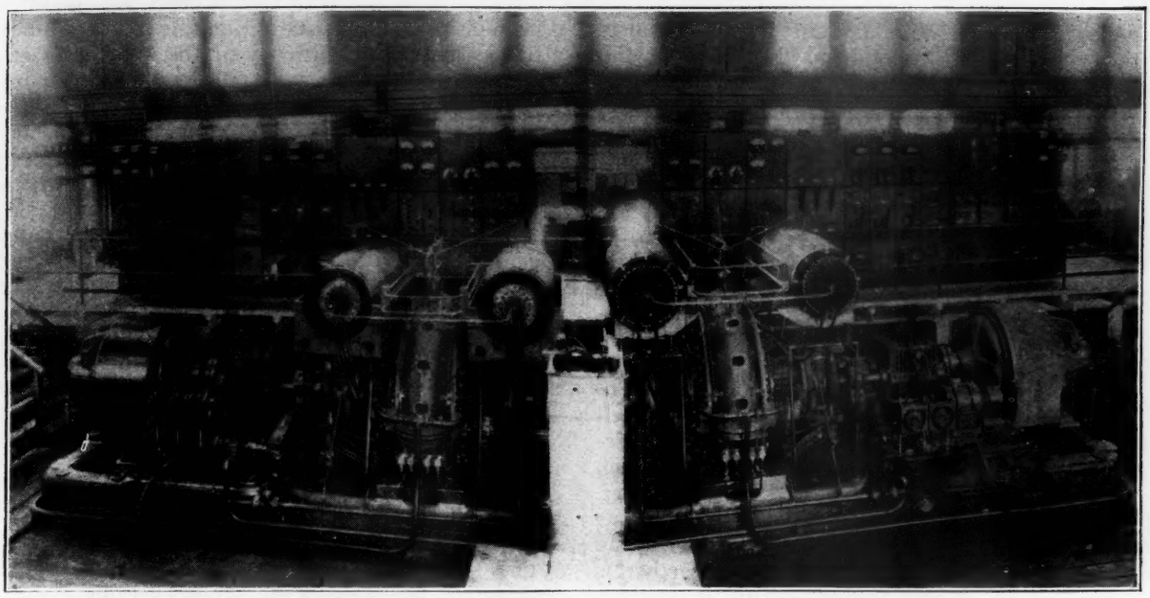
A third school of knowledge was at that time brought into contact with this technique and added new impetus to it. As soon as such scientists as Coolidge and Langmuir began to study the remarkable little device invented by Lee de Forest and known as the audion, the foundation was laid for the vacuum-tube technique which has so profoundly influenced the art of radio communication.

Analogy to Explain Transmission by Means of Radio.

These scientists tell us that electricity is not the mysterious power fluid that we may have imagined flowing smoothly in our wires, but miniature planets or comets of condensed material electricity of definite charge and mass shooting across a miniature universe inside of a glass bulb and following orbits that can be calculated as accurately as the orbits of the stars.

Keeping in mind the origin of the modern art of radio communication in these three widely separate realms of knowledge, power engineering and electro physics, we may now proceed to examine the essential parts. We find then, first, a modern electric power plant working at high frequency; second, a network of wires a mile long, supported on tall masts, and third, on the opposite side of the ocean a little glass bulb full of shooting stars. The question is: what does really happen?

Does the electricity generated by our alternator emanate from the antenna and flow in an undulating stream through the air or through the



Installation of Two-Unit Radio Station Using 200-Kw. High-Frequency Alternators.

water or through both? If we search for it in an aeroplane, we find it, and if we submerge ourselves in a submarine and search for it, we find it, and yet we are told it is not so.

Does the little electron, as an individual, take a leap off the aerial wires and after devious paths find its home in the glass bulb on the other side of the ocean? We are also told that it does not.

If I knew what really does happen, and should try to tell you, then sooner or later somebody would claim that I was altogether mistaken. Therefore, I will only try to tell you how I imagine that it happens, wondering if any of you will see the same mental picture of the process that I see.

We were once told by the physicists that all space was filled by a fine substance that was called ether, and that the light and heat that radiated from the sun was a wave motion in the ether. The physicists now tell us that there is no ether, but still they say that light is a wave motion. Be this as it may, for the purposes of visualizing what takes place in radio transmission, it is convenient to cling to the theory of the ether.

We are familiar with other forms of wave motion—the air waves that carry sound to our ears and the water waves on the ocean. Thus the carrier of the radiated electric energy must not be likened to the flowing stream of water, or to the wind or to a bullet shot from a gun, but likened to a wave in a uniform medium where each particle of the medium oscillates around a stationary base line while the wave rolls forward.

Distance of Communication Depends Upon Wave Length Used.

The distance that a wave can travel before it fades out is proportional to its length. We may therefore introduce the idea of wave length, which is the distance from the crest of one wave to the next. The long swells of the ocean travel for hundreds of miles, whereas a pebble dropped on a still surface of water produces a ripple that fades away in a short distance.

In radio communication it has been observed that the distance over which reliable communication can be maintained is about 500 times the length of the ether wave that is used. It may be more than a coincidence that the distance to which a sound wave travels in air, and a wave on the surface of water will travel before it fades out is also about 500 wave lengths. The average wave length of sound of spoken words is about 1 ft., and we know that if we speak loud our voices will carry a distance of about 500 ft. The exceptions to this rule that will occur to anybody are also significant. We know what distances voices will carry over a lake in a quiet evening. We also know what extraordinary distances radio signals will carry sometimes on a quiet night. These are exceptions that prove the rule and the rule refers only to reliable communication under normal conditions.

A radio transmitting system is designed for the purpose of producing waves in the ether which we call electromagnetic waves, and for controlling the rate at which the waves are produced, in such a way that a train of successive waves will carry the meaning of articulate speech or telegraphic code. If we wish to send a message a long distance, we must select a long wave. The distance to Europe is 5000 kilometers. If this distance is to be bridged by 500 wave lengths, each wave length must be at least 10 km. (6 mi.) or, as it is usually expressed, a wave length of 10,000 m.

We can produce water waves by rocking a boat. If we rock a canoe we get a short wave, but if we rock a larger boat we get a correspondingly longer wave. To rock the boat requires energy, but in order to produce a wave of suitable length, the energy must act through an intermediate member which has suitable size and proportions.

In radio transmission the energy is furnished by the high-frequency power plant, but in order to transform this energy into waves there is required the intermediate member which makes contacts with a large volume of the medium

which carries the wave motion. This medium is the ether and corresponds to the water or the air in the more familiar forms of wave motion. The member that transfers the energy to the ether is the antenna. The waves used for transatlantic communication are as a matter of fact 10,000 meters or more in length. The antenna corresponds to the hull of the rocking boat or the sounding board of the piano.

The analogy with water waves may be carried still further. The wave is a successive displacement of the medium, and the initial displacement produced by the member acting upon the medium is proportioned to its volume. The water displacement of the boat corresponds to the effective volume of the antenna. The maximum voltage at which the antenna can be operated corresponds to the maximum angle to which the boat may be rocked before it ships water. This is the voltage at which the surrounding air breaks down under the electrostatic pressure. In electrical units the displacement in the ether is expressed in ampere-meters. This is really a measure of volume as is apparent from the consideration that the amperes of charging current at the limiting voltage is proportional to the two horizontal dimensions. The third dimension, or the height, appears directly in the product and is expressed in meters.

Ether Displacement New Basis for Design of Antenna.

The height of the antenna is the most expensive of the three dimensions by which we may create electric displacement in the ether. The tendency in stations designed for greatest economy is therefore towards structures of moderate height and great length, whereas, the tendency in the past, when dynamic efficiency was the principal consideration, was towards towers of great height. The unit of performance on the old basis was kilowatts consumed by the antenna. The unit on the new basis is ether displacement. This modern measure of antenna radiating capacity is the number of ampere-meters of ether displacement that can be produced at the voltage which is limited by the breakdown of the air.

The antennas of the stations of New Brunswick and Marion which are now used in transatlantic service are each 1 mi. long. In the new radio central station which is being built by the Radio Corp. on Long Island there will be 10 or 12 antennas, each 1.25 mi. long. This station is intended to communicate efficiently with all parts of the world. When very long distances are to be spanned correspondingly long waves will be used. For efficient transmission of these long powerful waves an antenna will be needed that makes contact with a large volume of ether. This will be accomplished by combining several of these antennas into one unit. At other times the same antennas will be used for the simultaneous transmission of several messages over shorter distances.

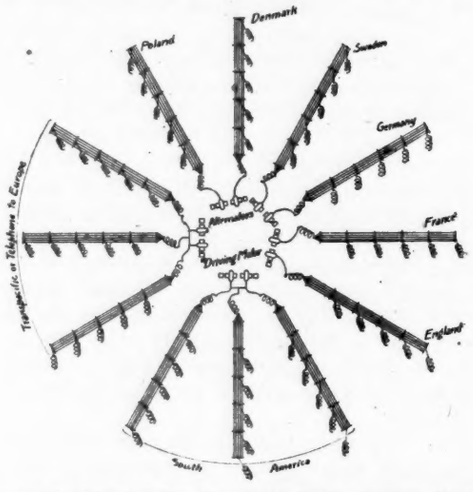
The shifting of radiation power which has been referred to is made possible by the use of the multiple tuned antenna. The New Brunswick and Marion antennas are now tuned so that each acts as six single antennas operating in multiple.

When two such antenna groups are connected in multiple the resistance loss is reduced one-half. Hence the efficiency of the antenna is increased so that a given power produces more radiation. Still more important is, however, the fact that more power may be utilized at this increased efficiency, and so the net result is that the amplitude of the radiated wave is doubled, which means that four times as much energy is radiated.

The economical factors that point to the radio central station as the practical solution of the problem of long-distance communication are practically the same as those that created the central electric power station. Broadly speaking, they provide for the utilization of the plant investment and operating force to the utmost by shifting the equipment from one service to another and combining it to meet various demands.

First Great Central Radio Station Installed Near New York City.

New York is a natural communication center and the service must extend to Europe, South America and westward. Another radio central



Antenna Corbination for New York Radio Central Station.

station at Hawaii is being equipped to serve as a relay for all points on the other side of the Pacific Ocean.

While it is winter on the northern hemisphere, the radiating power to Europe can be much reduced, but this is the season when the South American traffic requires a maximum radiation because of summer conditions then existing on the southern hemisphere. The New York radio central station can then divert some of its radiating power from the European to the South American circuits.

The realization of the transatlantic telephone for commercial purposes is another object of the radio central installation. The transatlantic telephone will, no doubt, be a luxury for some time to come. The radiation intensity needed for telephony is much greater than for telegraphy, and a plant designed purely for telephony might prove prohibitively expensive. However, the flexibility of the radio central, where any number of antennas can be combined when desired to produce a more efficient radiation, will make an extra powerful transmitter available when needed, while the plant may be used in a more economical way at other times for telegraphy.

Direct-Current Motors and Control Equipment

Second of a Series of Articles on Principles and Applications of Motor-Control Apparatus — Types of Direct-Current Motors —Characteristic Curves — Installation and Service Conditions

By G. J. KIRKGASSER and E. W. SEEGER

General.—In order to select the proper electrical equipment for any motor-driven installation it is necessary to know the characteristics of the different types of motors as well as the different kinds of controllers. The type of motor required depends upon the machine to which it is connected and the work to be done. The design of the controller is in some cases affected by the type of motor selected. In the following discussion it is assumed that the reader is familiar with direct-current motors. The operating characteristics of the different types will merely be pointed out without any attempt to explain the theory of operation.

There are three types of direct-current motors in general use—shunt, series and compound. The armature connections are the same for all types, but the field windings are different. Practically all direct-current motors are started with resistance in series with the armature, and this resistance is cut out step by step as the motor accelerates. If the motor has a shunt field the connections are usually arranged to give full field strength during starting.

Shunt Motors.—The connections of a shunt motor are shown in Fig. 5. The field winding

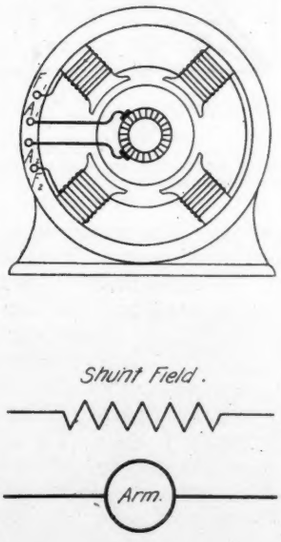


Fig. 5.

Shunt-wound motor with across-the-line type of diagram shown below.

consists of many turns of fine wire and is connected directly across the line. The excitation, therefore, is constant, and, as the speed depends on the field strength, the speed is practically constant for all loads. For this reason the shunt motor is generally used on line shafts and similar drives where constant speed is desirable.

The speed of a shunt motor may be varied by inserting resistance in either the armature or field circuits. If external resistance is placed in the armature circuit there will be a drop in voltage across the resistance, thereby reducing the voltage across the armature. As the speed of the motor is almost directly proportional to the counter e.m.f. generated by the motor it will slow down as resistance is placed in the armature circuit. The speed can also be varied by increasing or decreasing the resistance in the field circuit. The explanation of this action is that when the armature is directly across the line the line voltage must be practically balanced by the counter e.m.f. generated by the motor. If the field is weakened it will therefore be necessary for the armature to revolve faster in order to generate the necessary counter e.m.f.

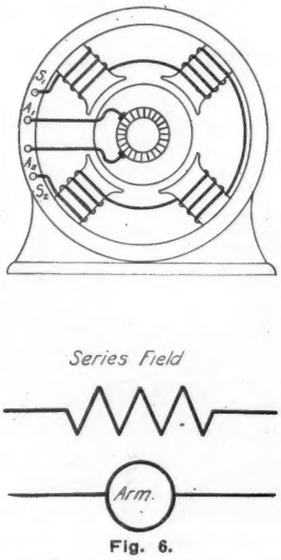


Fig. 6.

Series-wound motor with across-the-line type of diagram shown below.

Series Motors.—The connections of a series motor are shown in Fig. 6. The field winding in this case consists of a comparatively small number of turns of large wire and the full motor current is carried through the windings. As the speed of a motor depends on the field strength, the speed of the series motor varies with the load, running slow on heavy loads and faster on light loads. At no load the motor will overspeed, and for this reason the series motor should never

be used to drive any machine where the load is liable to be entirely disconnected. Series motors find their widest application on street cars, cranes, fans, etc., where the load is always connected to the motor. The speed can be regulated by inserting resistance in the motor circuit.

Compound Motors.—The connections of a compound-wound motor are shown in Fig. 7.

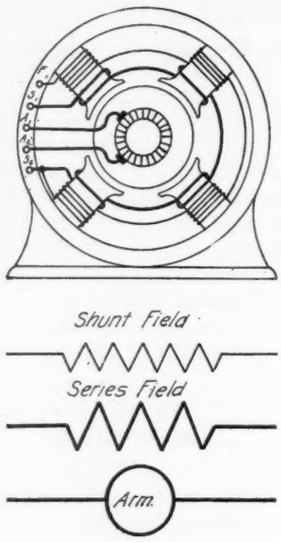


Fig. 7.

Compound-wound motor with across-the-line type of diagram shown below.

This motor has both shunt and series field windings. There are two types of compound-wound motors—cumulative and differential. In the differential compound-wound motor the series field opposes the shunt field, and the motor speeds up as the load increases. This type is not common, the cumulative compound-wound motor being the type generally used. The effect of the field coils is accumulative, and for this reason the motor speed decreases as the load increases. The speed of a compound-wound motor can be regulated by inserting resistance in either the armature or shunt-field circuits.

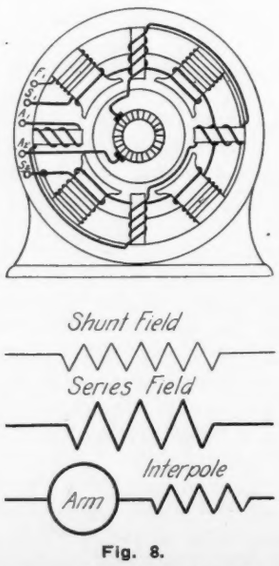


Fig. 8.

Compound-wound motor with interpoles, with across-the-line type of diagram shown below.

Interpole Motors.—A great many motors are supplied with an additional winding connected in series with the armature. This winding is placed on intermediate poles, as shown in Fig. 8, and is known as an interpole winding. It is used to balance armature reaction, and in this way reduces commutator trouble. The additional winding is not usually necessary on non-reversible machines because it is possible to shift the brushes and so prevent sparking. On reversible machines, however, and on non-reversible machines with a wide range in speed, interpole windings are desirable.

Motor Characteristics.—Fig. 9 shows the difference in characteristics of the shunt, series and

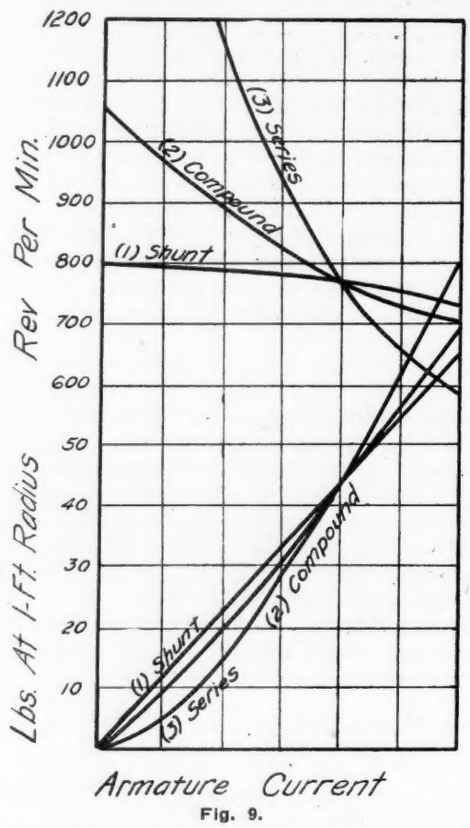


Fig. 9.

Curves showing difference in characteristics of shunt, series and compound motors.

compound motors. The upper curves are plotted between current and speed. It will be noted that the speed of the shunt motor is practically constant between no load and full load, while the speed of the series motor decreases rapidly as the load increases. The compound-motor curve is, of course, between the other two, and the exact position of this curve depends on the amount of compounding. If the series field is strong compared to the shunt the curve will approach that of the series motor, while if the shunt field is stronger the curve will be more nearly like that of the shunt motor.

Reversing of Direct-Current Motors.—Changing the direction of rotation of a direct-current motor may be accomplished by reversing either the armature or field connections, but the usual method is to change those of the armature rather than those of the field. On a compound-wound machine it would be necessary in reversing

the field to interchange both the series and shunt winding connections, which is, of course, more complicated than reversing the armature connections. If the motor has an interpole winding it should be included in the armature circuit when reversals are made.

Installation Conditions.—The standard open-type motor will give satisfactory results on the majority of installations. There are some instances, however, where special types of motors

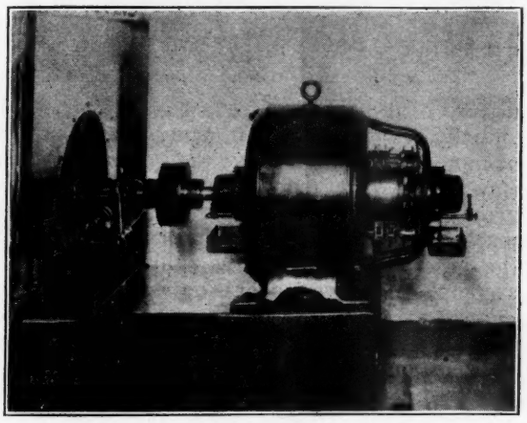


Fig. 10.

A standard general-purpose motor driving a fan. Speed regulators are mounted on the wall for controlling two of these motors, and have circuit-breakers in place of fuses for overload protection.

are required. In extremely dusty places a great deal of commutator trouble is sometimes experienced, and in these cases an inclosed motor should be used, or a protective housing provided if a standard motor is installed. Inclosed motors should also be used when the motor may be exposed to the weather. Railway motors and motors on outdoor cranes are protected in this way. In many cases it is possible to use an open-type motor and build a protective housing around it.

If a motor is to be installed in a place where the temperature is higher than normal it is usually best to use one larger than that actually required by the load. There is then less danger of injuring the insulation.

Service Conditions.—There are several types of motors on the market at the present time for different classes of service.

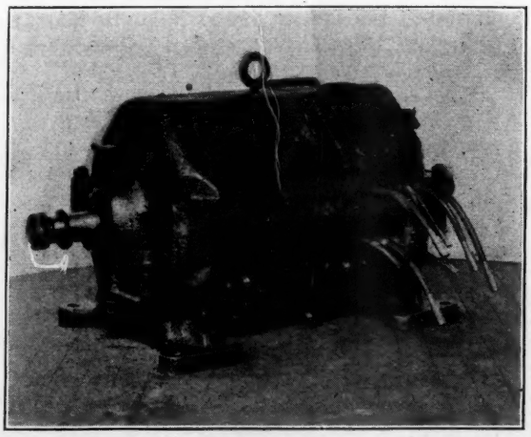


Fig. 11.

A 25-hp., 220-volt, 600-r.p.m., mill-type motor, with series and shunt field windings, made by the Crocker-Wheeler Co.

The standard general-purpose motor is used for pumps, fans, line shafts, etc. Fig. 10 is an example of this type of motor.

A special line of motors has been developed for steel-mill work, where the operating conditions are extremely severe. These motors are continually started, stopped and reversed, and in addition are usually handled by operators without any knowledge of motors. For this class of service the main requirements are ruggedness and reliability. Fig. 11 shows the type of motors used for this service.

It has also been found necessary to design special motors for elevators, Fig. 3* showing one of this type. The majority of these motors are compound wound in order to obtain a high starting torque and quick acceleration. The series winding is short-circuited when the motor is up to speed to prevent overspeeding with an overhauling load. With a compound-wound motor the torque builds up so rapidly that an unpleasant jerk is often felt in the car, and the recent tendency in design for high-speed passenger-elevator service has been toward the shunt-wound motor.

The motor shown in Fig. 12 is another example of a machine designed to meet special

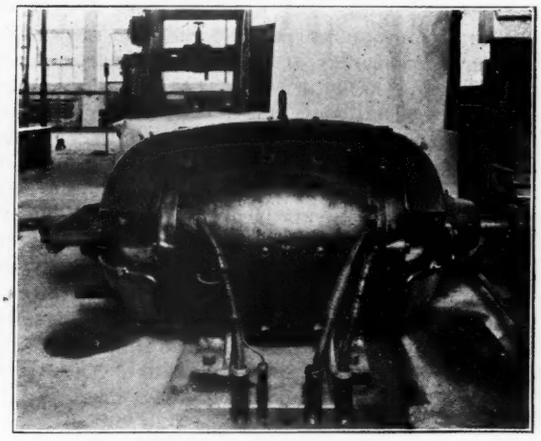


Fig. 12.

Motor provided with long armature of small diameter to reduce the flywheel action; especially made for service requiring frequent reversal, as on planers. The motor shown is of a type manufactured by the Electro Dynamic Co.

service conditions. This motor was built especially for planer service, and a long, small-diameter armature is used to reduce the flywheel action and enable comparatively quick reversals

(To Be Continued.)

DECISION ON DISTRIBUTING COMPANY'S RATES.

The Public Service Commission of Pennsylvania has handed down a decision in a case brought by the Pine Grove Electric Light, Heat & Power Co. for permission to amend its tariffs. The company purchases its power and operates local distributing lines. In asking for additional information relative to costs the commission says that the "practice of advancing rates by a distributing company is wrong in theory and that utilities which happen to be consumers cannot pass along burdens to their patrons without exercising ordinary business precautions."

*Refer to page 836, Nov. 27 issue of Electrical Review.

Recording Meters in Steel-Mill Equipment Testing

Suitability of Motors and Control Equipment for Given Services Determined by Analysis of Meter Chart Records—Actual Operating Conditions Checked and Recorded Continously by Use of Meters

By R. N. VINING

Steel working involves the application of heat and power. Heat is applied to prepare the steel, and power is required to work and handle it. In the more modern mills the application of power to the varied requirements of rolling and manipulating is performed through the medium of the electric motor.

The work required of steel-mill machinery is quite varied in character, the processes involved being those of lifting, lowering, transfer, twisting, turning and combinations of many motions. Mechanisms must perform the work of human hands, and a machine must translate the quick manipulation of its master into the responsive movements of tons of material. Operations are accomplished by using gears, racks, screws, cranks, levers, cams and various other devices. The load imposed on driving motors may be due to a direct lift against the action of gravity, it may be work in overcoming friction, or the inertia load may require a large portion of the available power. The load generally varies considerably during the cycle of operation. In lowering the ladles the load is overhauling and requires a restraining torque against the action of gravity. Machinery driven at rapidly varying speeds, or rapid reversals in direction, requires some form of braking, generally, to overcome the inertia of the parts.

Steel-Mill Loads Differ From Other Types.

The general character of the drives differ widely from the more common industrial drives requiring continuously running or constant-speed motors. Variations of power input and speed are quite pronounced on many of the steel-mill drives. The machines are not only of the individually driven type, but in many cases a number of motors are used to drive the separate mechanisms of the same machine. Separate parts of a given machine must operate in unison, and the machine must perform its function in step with the other apparatus in the mill. The time to accomplish a given operation is of paramount importance. This does not necessarily mean that all apparatus must be geared up for the highest speed obtainable, there being a limit to speed in all operations. Short distances of travel with accurate stops require lower operating speeds than longer travels of mechanisms acting simply as a carrier. There is also a velocity limit which cannot be exceeded without destructive results to the machinery, or a loss of traction of steel on the rollers. There is also a speed limit imposed in the interest of safety of operation.

Tests Required to Determine Actual Operating Conditions.

Steel-mill machines require rugged driving motors which will operate under severe service conditions. Motors must be capable of supplying heavy torques to rapidly accelerate or retard the apparatus. The control is generally of the full-magnetic type manipulated for direction of operation or selective-speed points by the operation of a master switch. In order to produce smooth and economical operation much attention must be given to the selection of the driving motors, the gear ratio and the motor control. Even if the most advantageous drive and control has been specified and installed, the success of the operation depends largely on the adjustments of

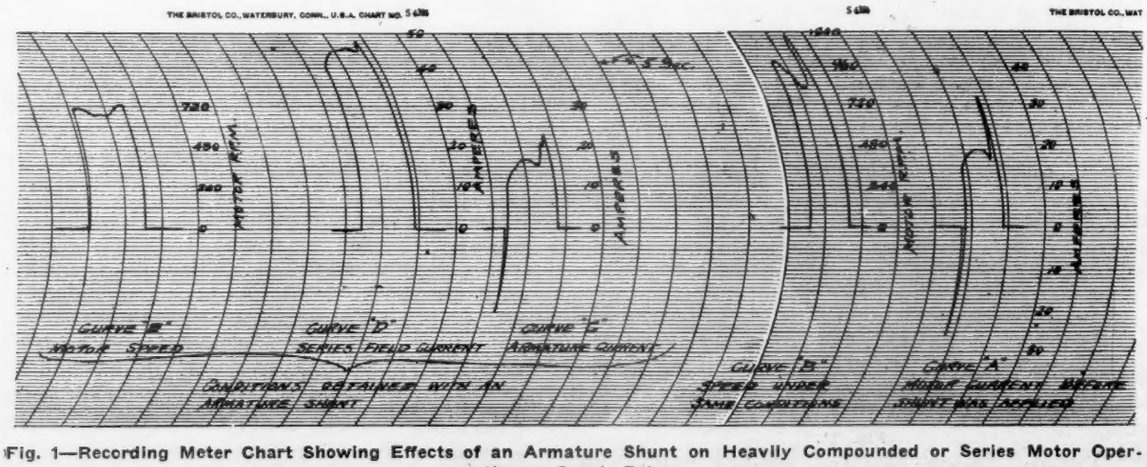


Fig. 1—Recording Meter Chart Showing Effects of an Armature Shunt on Heavily Compounded or Series Motor Operating a Crank Drive.

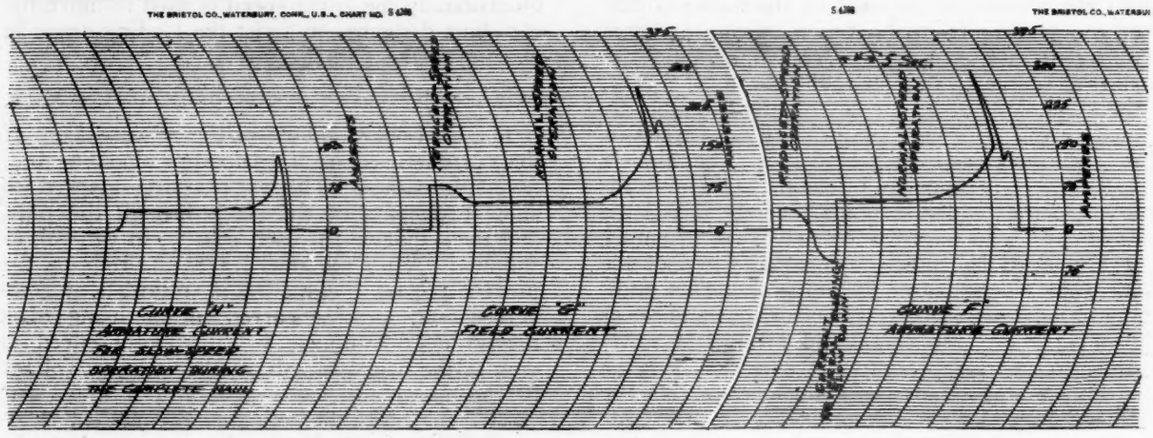


Fig. 2—Recording Meter Chart Showing Effect of an Armature Shunt on Operation of Motor Driving an Ingot Buggy.

the equipment and particularly upon the adjustments of the automatic features of control.

Points in connection with the design and operation of the drive can best be determined by making tests of the driving motors. The recording meter is best adapted to this line of work since an indicating meter will fluctuate too rapidly to permit taking readings of most of these drives. Then, too, the element of time is recorded in measurements taken by the recording meter. It may be desired to obtain the total time required to complete a given cycle, or to accelerate, retard or reverse the apparatus together with the motor torque applied.

An actual record taken of a given motor will not only record the starting peak, the time to get up speed, the load current and braking loads, but it will also clearly show the variations occurring in actual operation. A record will show the manner in which the machine is handled, and inching and plugging operations can be picked out on the charts. Much comparative data of instantaneous values of current, voltage and speed can be obtained by making tests with more than one meter at a time. Or, in the same manner, the characteristics of two or more mechanisms can be readily compared by taking simultaneous charts of each drive.

It is an advantage to use testing equipment which is interchangeable. This permits comparative calibrations, not only of the meters, but also of the external testing apparatus. If a certain type of meter can be used to obtain a large variety of data, fewer meters are required. As an example of the possibilities of recording meters in tests of this nature, several charts taken with d-c. apparatus have been selected. All charts were taken on the same meter.

The meter used in the tests was a Bristol millivoltmeter, Model 726. The full range of the meter is 100 millivolts, corresponding to the full scale deflection. An adjusting screw is provided to shift the zero position of the recording pen to any position over one-half the range of the chart. With the pen set directly on the center, the full-scale deflection is 50-0-50 millivolts. The clock mechanism is arranged for chart speeds of 1, 3 or 6-in. travel per minute, or the same rates per hour. The higher speeds are based on most of the work here described.

To obtain current readings an external shunt is used, the possible variations in sizes of standard shunts adapting the meter for use on capacities of sufficient range to include all motors involved. Unidirectional current flow is measured by adjusting the pen for a zero position at or near one edge of the chart, while a reversing current requires a pen setting close to the center of the chart. The actual position will depend on the magnitude of the fluctuations. To use the meter as a recording volt meter a suitable multiplier is required having a ratio to produce the desired deflction on the chart. Either a continuous or reversing polarity may be recorded by shifting the pen. Speed readings are recorded by using a magneto and multiplier in connection with the recording meter. The magneto has a straight-line voltage-speed characteristic so that for any given speed of the magneto a definite deflection is obtained on the chart. The magneto may be driven from the motor shaft, or other shaft of the machine, by means of chain and sprockets or cord and pulleys. As the magneto is quite small it is often possible to use it in the same manner as a hand tachometer, the magneto shaft being fitted with a suitable rubber tip for such service. For all variations of motor speed the magneto voltage will show a corresponding variation, the magneto voltage variation being recorded by the millivoltmeter pen. The multiplier must be suitable to adapt the magneto voltage, probably 20 volts at 1000 r.p.m., to the desired deflection of the pen.

Crank-Driven Machinery Has Peculiar Load Characteristics.

Machinery which is driven by a crank imposes a variable load on the motor. Fig. 1 represents the current load and speeds of a heavily compounded motor driving a gas-valve reversing equipment by means of a crank. The driving motor is rated at 5.5 hp. on a 1-hr. rating. Motor fields are of 70% series and 30% shunt windings, the series field not being used in dynamic braking. The motor speed characteristic is nearly as variable as a straight series motor.

The crank revolves through 180 deg. during each stroke of reversal. The motor current is light at the start of the stroke, but increases as the maximum crank position is reached and then diminishes to a minimum as the crank arm again approaches the horizontal position. When the crank is parallel to the driving rod (horizontal), as at the start and finish of each stroke, practic-

ally the whole load imposed on the motor is that of the gearing friction. Curve *A* of this chart represents the armature current including the starting current, the load current and, finally, the dynamic-braking current required to stop the mechanism. Curve *B* shows the large variations of speed obtained on this drive. The highest speeds were particularly injurious to the machinery, and the sudden stopping severely jarred the apparatus. To improve the drive, the armature was shunted by sufficient resistance to increase the field strength by 30 amperes. This additional field current was sufficient to stabilize, as well as lower, the speed and produce a fairly uniform and safe operation. The curves taken after the correction was made are as follows: Curve *C*, armature current; curve *D*, field current, and curve *E*, motor speed.

Armature Shunted for Overhauling Loads.

Overhauling loads are handled by shunting the armature with a resistance. Overhauling loads of weight impose a more or less constant braking load on the motor if the motor continues to run at a definite speed, but overhauling loads of inertia will produce quite a different effect. A load of the latter character is shown in Fig. 2. This chart was taken of a 40-hp. motor driving a 2.5-ton ingot buggy. The car is operated at a speed of approximately 250 ft. per minute in the run to the mill tables and is then suddenly slowed down to 100 ft. per minute. This speed is maintained while placing the ingot on the tables by means of the tilting mechanism.

During the main haul the motor is operated as a full series motor. The slow-down is accomplished by inserting a resistance across the armature and decreasing the voltage by opening two of the accelerating contactors. The armature current, as shown by curve *F*, Fig. 2, reverses to overcome the inertia of the car. As the inertia decreases the armature current finally recrosses the zero line and builds up to a value sufficient to supply the new torque demands. Curve *G*, Fig. 2, was taken of the field current under the same conditions, the field current being heavier than the armature current during the slow-down. The return run is made at high speed. Curve *H*, Fig. 2, was taken of armature current during slow-speed operation on the open track in order to obtain the available power in making a start from rest under these conditions. Occasionally the lower speed is used to move the car short distances to assist the loading crane in placing an ingot in the carriage.

Input to Reversing Motor of Blooming Mill.

The final chart, shown in Fig. 3, was taken of the current used by a 15,000-hp. blooming mill reversing motor. The curves are marked to show each pass of the steel through the rolls, and the sequence for each pass is, in general, as follows: After the steel leaves the rolls on the preceding pass the motor is retarded and reversed, regenerative current peaks being of a magnitude determined by the motor speed as well as the field strength and the relative voltage of the motor and motor-generator flywheel set; steel then enters the rolls and the current is increased due to the load of rolling, and to the accelerating current as the motor speeds up. The motor was operated at lower speeds during the first few passes, but the speed was gradually increased for the later and longer passes.

The actual test from which Fig. 3 was selected included many charts. By combining the data, the voltage and current of the motor were readily comparable to the resultant speeds during reversal and for given passes. A study of possible reductions per pass requires an accumulation of data of this nature. Much valuable data as to motor heating and general frequency of operation can be obtained by running the charts at a speed of three or six-ins. per hr. The meter may be left in circuit for the number of hours desired.

Comparison of charts which have been taken during successive days will furnish relative data of performance at different outputs or of different grades of steel or on different sizes of material.

BENEFIT OF ELECTRIC SERVICE TO FARMING COMMUNITIES.

Electric service on the farms is accredited with a large part of the six years' increase of $56,000,000 in land values in Tulare county, California. At the same rate, electric service on just one-fourth of the farms in the United States—the one-fourth nearest to present electric transmission lines—would increase United States farm values $20,000,000,000, a sum nearly equal to the total of the five Liberty loans.

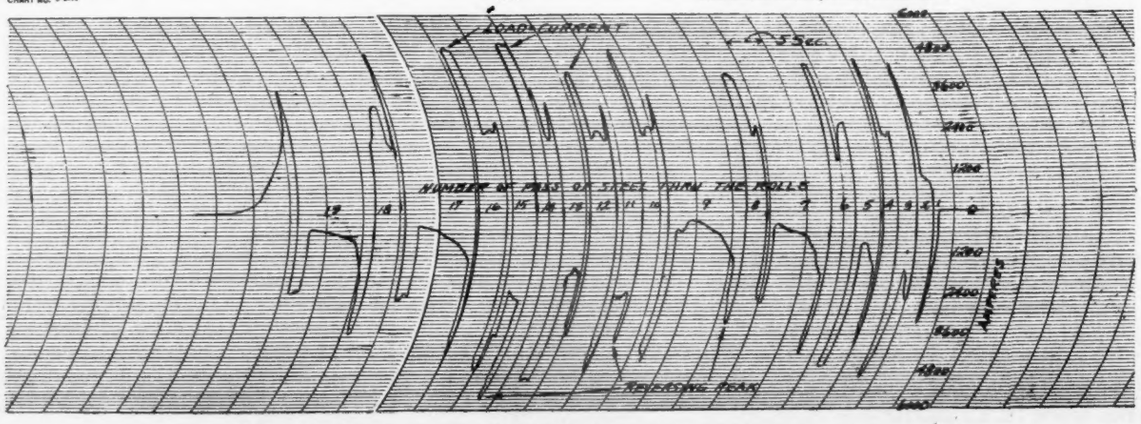


Fig. 3—Chart Showing Current in the 15,000-Hp. Reversing Motor of a Blooming Mill.

EDITORIAL COMMENT

Development of Large Turbines

To the central station belongs the credit for the large steam turbine; it was the central stations that offered the opportunity for the large turbine and so created the incentive to evolve it. For central-station operation the turbine has practically replaced any other form of steam prime mover in capacities in excess of 1000 hp., and for the majority of cases those in excess of 500 hp. The high load-factor and the steady load occasioned by electric light and power favored the use of turbines; the advantages of high efficiency, uniform rotating speeds, small amount of floor space required and low unit cost afforded by turbines soon made themselves obvious to the central-station industry.

Single-unit turbines have now become to be looked upon as quite ordinary up to capacities of 35,000 kw. A few years ago central-station companies that would have hardly been thought justified in installing anything larger than 15,000 kw. are today putting in machines of double this capacity. One-quarter of the total station capacity concentrated in one machine is not considered bad practice today. It would have been criticized as foolhardy three years ago—"putting all the eggs in one basket," it was called then.

The use of a few large turbines instead of a larger number of smaller ones does, of course, place greater dependence upon those installed. Reliability is proved, however, to be almost inherent to the large turbine, and disastrous or even serious interruption to a unit is the exception. For the accidents that have occurred there have been good reasons. And each reason has taught its lesson.

The trend in turbine capacities is well emphasized by the turbines ordered during this year. While financial conditions may have restricted orders, it does not appear to have been a factor in limiting the size of those that have been ordered. One manufacturer has received orders for four 35,000-kw. machines, six 30,000-kw. machines and four 25,000-kw. machines, besides orders for many smaller ones. These facts surely warrant the assertion that reliability of the larger machines is accepted as a proven fact.

Although it was the central stations that have created the need for large turbines and encouraged their evolution, the central stations no longer have a monopoly of the market for these huge machines. Very closely allied to the central stations, so far as concerns load-factor, concentration of power production in a centralized plant and electrical distribution to scattered load centers, are the battleship and the ocean liner. The central station has similar conditions to meet; they meet them in much the same way.

It is rather interesting to note that battleships have generating capacity comparable to that of the central stations. The largest cruisers now planned surpass the majority of central stations when it comes to size of individual units and total capacity. The "Tennessee," our latest capital ship, is equipped with 30,000 hp., while battleships planned call for 60,000 hp. apiece, comprised of two 28,000-kv-a. turbines. Two new cruisers will be equipped with four turbines of about 50,000 hp. each.

This is the age of big things. The central-station industry has accomplished many of them, as well as pointing the way to development in other lines. It is now demonstrated that it was the central-station industry that hastened the day of the superdreadnaught by making possible the superpower plant.

A Substitute for Transformer Oil

A toll of 13 lives seems a frightful catastrophy for a task that is almost an everyday affair somewhere in this land of transmission lines. Yet 13 men met death because a train of circumstances combined to set at naught almost every precaution known to the exponents of safety first. Hold cards, switch locks, written permits, the checking of apparatus, tests, ground wires and the repetition of orders are some of the things central-station companies practice to safeguard their men. These things are all done; yet 13 men lose their lives in a freak accident, apparently because a short-circuit caused the ignition and explosion of transformer oil.

Transformer oil, recognized as a potential fire hazard, has been singularly free, in practice, from causing trouble. Insurance interests long opposed its use in oil-filled apparatus, but the precautions originally taken to protect it and dispose of it in case of trouble are today usually given little consideration. There have been comparatively few fires, and the hazard has come to be looked upon as of academic rather than practical interest. Oil circuit-breakers explode occasionally, but the number of instances where flaming oil is scattered over combustible material seems singularly rare; in fact, when the number of oil circuit-breakers in actual use is considered, the

number causing fires is almost infinitesimal. Yet the danger of the oil is ever present.

Many attempts have been made to find a substitute for transformer oil. It is to be hoped that the recent accident at Tonawanda, N. Y., will give new impetus to research that will culminate in the finding of a substitute. There is evolution with all things; why not with transformer oil?

Carbon tetrachloride has frequently been advocated and suggested as a substitute for transformer oil. It is noncombustible, has high fire-quenching properties, is an extremely high dielectric and quenches the arc, and it is not hygroscopic as is transil oil. Unfortunately, carbon tetrachloride is extremely volatile and difficulty would be experienced in preventing its evaporating from circuit-breaker cases and transformers. It is a powerful solvent of rubber, being used commercially for this purpose. It is expensive. It is heavier than water and introduces difficulties in handling and storing. Its volatility appears to prevent its use as a substitute for transformer oil.

Solid insulation is being used instead of oil for small high-potential transformers. The compound is a liquid when heated, but solidifies at temperatures below about 50 deg. C. While the use of such material introduces the possibility of air voids, ionization, corona and possible failures, such a compound has the advantage that it will not spill nor scatter should an explosion occur. It would not be feasible, of course, for circuit-breakers.

Notwithstanding the fact that carbon tetrachloride possesses so many desirable characteristics, its high volatility appears to preclude its use, although experiments are still being carried on with circuit-breakers where it has replaced the customary oil. Meanwhile what the electrical industry needs, and the central-station industry in particular, is a liquid insulating medium that will not burn, evaporate, or freeze above —15 deg. C., will not take up moisture, has the required viscosity and dielectric strength, and is of low cost. To discover such a liquid is a task deserving the best talent in the land.

Courtesy and Service in Business

An electrical contractor was somewhat surprised at receiving a request to submit a bid on a job of house-wiring work in a neighborhood far away from the district where he usually operated. The request to bid on the job was accompanied with the stipulation that a certain employe on the contractor's force should do the work. Inquiry on the part of the contractor, after the job had been completed to the satisfaction of the customer, revealed the fact that the man for whom the work was done had been favorably impressed by the wireman while observing his work in the home of a friend. Courtesy, attention to little details, and an evident desire to please had won his confidence and, ultimately, his order for work. Incidentally, the workman had only been carrying out the instructions of his employer, for "Courtesy and Service" was his business slogan.

Such principles are not the grounds of success for a contractor-dealer only, but may be applied to every business and to every branch of a business. In the end, the big things are all found to be made up of a number of smaller ones, and close examination often shows that the small parts are themselves made up of further details, and so on. The success of the electrical industry has been built up during past years on a basis of service.

The essence of service is the giving of something for which no return is asked or suggested. A return may and should be expected for service well rendered, but where compensation is demanded there is no element of service. There seems to be no manner by which the electrical industry can maintain its progress and good name than by giving unstinted service. This service has so many different possible forms that the industry seems to be in an exceptionally favorable position to gain the good-will of the entire public. The contractor may render a slight service, possibly annoying to him and taking a few moments of time, but greatly pleasing the person for whom it is rendered. In most cases the person in question would never be able to do for himself what the contractor or his employe did in only a few moments. Now, if that same person later called to enquire at the offices of the central-station company about an erroneous bill and received prompt and courteous attention, he would again be pleased. If the dealer who sold this same customer a washing machine should make sure that everything was right and that proper materials and methods were available and being used to make the washer actually clean the clothes put into it, the customer would be pleased again.

It is hardly possible that an individual could have three such experiences without their making an impression, and a favorable one. But if in one or two or all three places where the customer spent his money he should fail to receive courteous attention, he would also be impressed, and the impression made would not work for the good of the electrical industry. An individual may soon forget a favor, or may forget many of them, but discourtesy or dissappointments are not forgotten so easily. And a person once disgruntled is hard to win back, particularly if a public-service agency be the object of disfavor.

THE WEEK'S NEWS

Reports of Important Meetings, Developments and Other Happenings of the Electrical Industry and Its Allied Interests

RESOLUTIONS ON PUBLIC ATTITUDE TOWARDS UTILITIES.

St. Louis Electrical Board of Trade Indorses Resolution Recently Adopted by Chamber of Commerce of Borough of Queens.

The executive committee of the St. Louis Electrical Board of Trade at a recent meeting adopted the following resolution relative to the attitude of the public toward public service corporations:

"Resolved, that the St. Louis Electrical Board of Trade heartily indorses the following resolution as squarely representing the relationship that should hold between the public and the public utiltiy corporations, with the addition in our recommendation to the state utilities commission of an allowance for the amortization of bonded indebtedness, thus making the public secure in their investment in securities of this character; and

"Resolved further, that the secretary-manager order these resolutions printed; a copy sent to each member of the St. Louis Electrical Board of Trade; to each member of the Missouri Public Service Commission, and that this action be given the widest publicity in the state press."

RESOLUTION OF BOROUGH OF QUEENS CHAMBER OF COMMERCE.

"Whereas, the chamber of commerce of the borough of Queens recognizes that the best interests of the community require that its public utilities, including the surface, elevated and subway, electric and water companies, should perform their obligations to furnish adequate, continuous and dependable service to their patrons, the public, and

"Whereas, such service cannot be furnished unless the rates collected therefor are sufficient to pay operating expenses, maintain the plants in condition capable of rendering efficient service, maintain its credit and pay a fair return upon the capital invested in the property devoted to the public use; now therefore, be it

"Resolved, that the chamber of commerce of the borough of Queens demands that the municipal and other public authorities having supervision or regulatory power, contractual or otherwise, over the rates of public utilities take such action as may be necessary in order that such corporations may hereafter charge rates sufficient to enable them to pay all expenses of operation, including maintenance of plant and equipment, maintain its credit, as well as a fair return upon the capital invested in the property devoted to the public use, and in consideration of such adequate rates for service the public utilities be required to render proper and efficient service to the public."

AMERICAN ENGINEERING COUNCIL ELECTS OFFICERS.

The American Engineering Council, the governing body of the Federated American Engineering Societies, held its first meeting in Washington, D. C., last month, and elected Herbert Hoover, former food administrator and president of the American Institute of Mining and Metallurgical Engineers, president. In a speech following his election, Mr. Hoover outlined a basis of common agreement between capital and labor, and urged that engineers link their efforts with those of labor in a solution of industrial problems.

The other officers elected were: Vice-presidents, Calvert Townley, American Institute of Electrical Engineers; W. E. Rolfe, Associated Engineering Societies of St. Louis; Dexter S. Kimball, American Society of Mechanical Engineers, and J. Parke Channing, American Institute of Mining and Metallurgical Engineers; treasurer, L. W. Wallace, Society of Industrial Engineers; temporary secretary, L. P. Alford. It was decided to establish headquarters at Washington, D. C.

As one of its first activities in the interest of public service the federation plans to inaugurate a nation-wide quantitative survey of industrial wastes, to include among other special lines of inquiry the aggregate loss to industry and to the public caused by strikes and lockouts, intermittent employment and unemployment due to the shifting of industrial currents, etc.

WESTERN ELECTRICAL INSPECTORS TO MEET IN DETROIT.

Grounding of Circuits and Safeguarding Fixtures Among Subjects to Be Discussed at Annual Meeting, Jan. 25-28.

A tentative program for the sixteenth annual convention of the Western Association of Electrical Inspectors, to be held at the Hotel Statler, Detroit, Jan. 25-28, has been announced. The association has issued an invitation to all those interested in inspection work to attend the sessions and participate in the discussions. An outline of the program follows:

Jan. 25, 10 *a. m.*—Address of welcome by Mayor James Couzens of Detroit; reply by Vice-President James H. Fenton, St. Louis; address by President K. W. Adkins; reports of executive committee, secretary and treasurer and appointment of nominating committee; addresses by Edwin L. Crosby, president and general manager of the Detroit Electric Furnace Co., on "The Electric Furnace" (illustrated); George B. Muldaur, general agent of the Underwriters' Laboratories, Chicago, on "Why Is a General Agent of Underwriters' Laboratories?"; Hubert J. Clark, engineer of the Oklahoma Inspection Bureau, Oklahoma City, on "Transformer Values—Location, Construction and Equipment"; Washington Devereux, chief electrical inspector of the Philadelphia Fire Underwriters' Association, on "Regulating Motion Picture Theaters."

Jan. 25, 2 *p. m.*—General subject of "Grounding of Electric Circuits and Apparatus": (a) "The History of the Grounding of Secondaries," by F. A. Barron, engineer of the wiring supplies department, General Electric Co., Schenectady, N. Y.; (b) "The Central Station's Responsibility," by speaker to be chosen; (c) "The Electrical Contractor's Responsibility," by Emil Anderson, Standard Electric Co., Minneapolis, Minn.; (d) "Municipal Co-operation," by Gerald J. Wagner, director of public service, Grand Rapids, Mich.; (e) "The Grounding Rules," by speaker to be chosen. General subject of "Safeguarding Electric Fixtures": (a) "Manufacturing and Shipping Problems," by the president or secretary of the National Council of Lighting Fixture Manufacturers; (b) "Factory Inspection Problems," by Dana Pierce, vice-president of the Underwriters' Laboratories, New York City; (c) "Installa-

tion Problems," by J. L. Wolf, secretary of the Lighting Fixture Dealers' Association of America, Detroit; (d) "Inspection Problems," by Victor H. Tousley, chief electrical inspector, Chicago; address on "Inductive Interference with Signal Circuits," by W. J. Canada, director of engineering, National Electric Light Association.

Jan. 26, 10 *a. m.*—Inspectors' problems: Address by D. A. Raymond, engineer of the National Board of Fire Underwriters, New York City, on "Effect of Electrical Inspection and Municipal Fire Alarm Systems on Fire Insurance Rates"; general subject of "Improving Old and Defective Wiring Installations": (a) "The Municipal Inspector's Method," by Ben W. Clark, chief electrical inspector of the Detroit Building Department; (b) "The Underwriters Inspector's Method," by F. G. Waldenfels, chief electrical inspector, Chicago Board of Underwriters; (c) "The Central Station's Co-operation," by L. D. Smith, general superintendent of the Minneapolis General Electric Co.

Jan. 26, 2 *p. m.*—Address by H. M. Gould, electrical engineer of the Street Railway Commission, Detroit, on "Electric Welding of Traction Rails." Discussion of inspectors' problems which have been submitted to the secretary in writing.

Jan. 27, *Morning and Afternoon Sessions.*—Reports of special committees, new business, report of nominating committee, and election of officers.

Jan. 28 will be devoted to inspection tours.

NEW SECTION OF I. E. S. FORMED IN CLEVELAND.

In accordance with the authorization received from the council of the Illuminating Engineering Society, plans are being made for organizing a section of the society in Cleveland. J. R. Colville has been appointed temporary chairman, and E. Du B. Stryker chairman of the membership committee. This is the fifth section to be formed, sections already being in existence in New York, Philadelphia, Chicago and New England. The first meeting was held jointly with the Cleveland Section of American Institute of Electrical Engineers on Nov. 16.

GOODWIN SPEAKS BEFORE CHICAGO ELECTRIC CLUB.

Taking as his theme co-operation in the electrical industry and intimating what could be accomplished through constructive work by different branches of the industry working in harmony, W. L. Goodwin, author of the "Goodwin Plan" and special representative of the General Electric Co., addressed the Electric Club of Chicago at its weekly luncheon Nov. 30. He grouped those in the industry into manufacturers, central-station companies, jobbers, contractor-dealers, engineers and street-railway companies, and said that each branch should attend to its particular function or job, and that it was the minor functioning of the branches that caused trouble.

He spoke at considerable length of the lack of standardization of voltages, cycles, attachment plugs, etc., emphasizing the confusion that resulted, especially in giving service to users of electricity. These difficulties should be ironed out, so that the electrical idea, as well as better service, may be sold to the public. He said that four years ago, with a capital investment of $14,000,000,000, the electrical industry did a business of $600,000,000; the latter figure has been increased to $3,000,000,000 in 1920, and should reach $10,000,000,000 in five or ten years, in order that a respectable turnover and profit could be secured. Real co-operation and not the attitude of "standing ready to co-operate" should be practiced.

It was Mr. Goodwin's first appearance before an electrical organization in Chicago, and he was greeted by a large number of guests and members of the Electric Club.

INDIANA CONTRACTORS TO ASSIST STATE UTILITIES.

All Branches of Electrical Industry Participate in Vital Consideration of Central-Station Problems at Annual Convention.

All other business was subordinated to that of action to revitalize the utilities of the state at the annual convention of the Indiana State Association of Electrical Contractors and Dealers, held in South Bend, Dec. 1. It was the largest meeting in the history of the organization and the entire electrical industry was represented by the 178 who were in attendance. As the result of the meeting the contractors and dealers of the state are pledged to not only invest in central-station securities themselves but to encourage such investment among their customers and to influence remedial legislation as far as possible.

The spirit of intensive co-operation marked the deliberations of the contractor-dealer members. Their invitation to the central-station men to participate in the convention had been met by prominent representatives who came with earnest pleas that the contractors and dealers help to save the utilities from extinction through lack of public confidence and political exploitation, thereby preserving the integrity and success of all branches of the electrical industry. The response was an emphatic resolution of practical support.

Goodwin Stirs Business Men With Message of Utility Logic.

William L. Goodwin, endeared to the electrical industry as the man who has done more than any other one man in the promotion of electrical appliance sales, was in attendance at the Indiana convention of contractor-dealers. The Rotary Club of South Bend, comprising about 200 of the leading business men of the city, was having a banquet at the Oliver Hotel in a room next to the meeting of the electrical men. Mr. Goodwin was invited by the Rotarians to address them at this noon-day gathering on the subject of public utilities. The message they received impressed them profoundly and they promised to consider the question of assistance to utilities with greater interest from the standpoint of public welfare and civic and industrial growth.

At the first session of the contractor-dealer convention Morse DellPlain, vice-president of the Northern Indiana Gas & Electric Co., of Hammond, Ind., presented a forcible paper on "The Contractor, Dealer and the Central Station." It was a convincing plea for the support of the men whose business existence depends upon the production, maintenance and extension of electric power.

At the annual banquet of the Indiana State Association of Electrical Contractors and Dealers in the evening William L. Goodwin, addressing

a gathering in which all branches of the electrical industry were well represented, pictured the central-station companies in their supplication to the contractor-dealer for help to preserve their existance. He predicted that under present conditions new developments must stop within a year. He said the central-station companies needed and should have immediately $3,000,000,000 or the cities of the country would cease to grow and industry become stagnant, because the growth of the cities is limited by the development of their utilities. Mr. Goodwin said that most of the utilities are now earning but 4.5%, while money is demanding 7% or better.

"Business is in every way a science and not an accident," said Mr. Goodwin, "and it is up to the contractor-dealer to see that the public utilities are kept in healthy condition. Your reward will be certain."

Plug and Receptacle Standardization and Collective Advertising Adopted.

Following a paper on "Standardization" by W. D. Yates, of the General Electric Co., the convention adopted a resolution to work for the employment only of standard plugs, receptacles and attachments on appliances in the state. Following a comprehensive talk on "Advertising" by Ainslie A. Gray, Chicago, a resolution was adopted calling upon manufacturers of electrical appliances to appropriate, over and above all other compensation to dealers, a sum to be used with like amounts from the dealers for local newspaper advertising. The matter of collective or co-operative advertising among dealers was indorsed.

"Lay your case before your banker plainly and without reserve," was the advice of Alfred E. Martin, attorney for the Citizens National Bank, South Bend, in an address on "Credit." The speaker urged closer relations between contractor-dealers and bankers as a solution of their business problems.

"We can if we will," was the chief thought embodied in the address of A. L. Swanson, electrical contractor, Evansville, Ind., on "Electrical Contracting." Mr. Swanson said that faithful application of his slogan would give the contractor the proper determination to obtain business at a profit and overcome the ills of ignorant competition. He urged the necessity of a proper accounting and estimating system and determination to stick by honest estimates. Comprehensive study of the industrial plants, business houses and residents of the community was suggested as the preliminary to accurate estimates.

Lawrence W. Davis, special representative of the National Association of Electrical Contractors and Dealers, pointed out that the principal benefit of organization was obtained when the members absorb information they receive at the meetings and apply that knowledge to their own business when they return to their homes. He urged the adoption of an adequate accounting system, the prompt collection of bills, closer co-operation with central-station companies and fuller recognition of the service rendered by the jobbers.

A. B. Harris, of the Lighthouse Electric Co., Gary, Ind., was re-elected chairman of the state association, and A. I. Clifford, of the Sanborn Electric Co., Indianapolis, was elected secretary-treasurer. The executive committee is composed of A. B. Harris, chairman, Northern Division, Gary; Thomas Hatfield, Hatfield Electric Co., chairman, Central Division, and A. L. Swanson, contractor, Evansville, chairman, Southern Division. Messrs. Harris and Swanson were re-elected to this committee.

PROMINENT MEN AT SOUTHEASTERN DIVISION MEETING.

Among those who took a leading part in the deliberations at the recent convention of the Southeastern Geographic Division of the National Electric Light Association held at Miami, Fla., were P. A. Tillery, Carolina Power & Light Co.,

Group of Notables at the Miami Convention of Southeastern Geographic Division, N. E. L. A.

Raleigh, N. C., and retiring president of the division, and S. B. Irelan, Montgomery (Ala.) Light & Water Power Co., the new president. S. A. Chase, Westinghouse Electric & Manufacturing Co., and W. L. Goodwin, General Electric Co., also added to the interest of the meeting by instructive addresses. These four were lined up at a favorable moment and "snapped" by a convention photographer, the result being shown above. Reading from left to right they are S. A. Chase, W. L. Goodwin, P. A. Tillery and S. B. Irelan.

RECOMMENDS POWER PLANT PROJECT FOR BUFFALO.

In a report tendered by F. W. Ballard, electrical engineer, Cleveland, to the city council of Buffalo, N. Y., by which body he was engaged to make an investigation regarding a municipal power-plant project, recommendations are made to abandon a project of this character and accept one of the proposals made by the local electric companies. It is pointed out that a municipal electric power plant as proposed by the city will cost $22,000,000, and in addition the city will not be able to operate the station at a low cost as evidenced in the case of the public utility company. The station, as projected, would have a capacity of 100,000 hp. and include a high-tension system from a site near Niagara Falls to the

city of Buffalo. Mr. Ballard recommends the acceptance of the Niagara County Irrigation & Water Supply Co.'s offer, which has made a rate of $15 per hp. per year. The proposal covers the erection of a hydroelectric generating plant by the company and co-operation between the two interests in the construction of a transmission line.

MEMBERS OF S. E. D. PUSHING CO-OPERATIVE WORK.

In furtherance of the use of electricity and developing co-operation within the industry, Thomas F. Chantler, a member of the staff of the Society for Electrical Development, recently addressed a meeting of the Maryland State Association of Electrical Contractors and Dealers at Baltimore. He spoke on the fundamentals of merchandising, his talk being illustrated with chalk sketches and diagrams. With a similar object in view, Harrison T. Matthews made a trip through Iowa, Illinois, Indiana, Wisconsin, Michigan and Ohio, and addressed the Iowa State Contractors' Association in addition to attending the semi-annual convention of the Electrical Supply Jobbers' Association at Cleveland last month. Mr. Matthews also spoke before the Cleveland Electrical League, Nov. 17.

The attractive cutout used in the society's electrical Christmas window-display campaign has won favor, and it is evident from the nation-wide interest expressed and the volume of orders received for material that more people will receive electrical Christmas gifts this year than ever before. The widespread use of the society's 1920 slogan, "Say Merry Christmas Electrically," is partly responsible for this result.

DUQUESNE SECTION, N. E. L. A., TO MEET NEXT WEEK.

In connection with its educational program, the Duquesne Light Co. Section of the National Electric Light Association has arranged to have M. C. Turpin, Westinghouse Merchandising Bureau, New York City, give an address on "Electricity Day" at the Dec. 6 meeting at Pittsburgh. The talk, which will be illustrated by lantern slides and motion pictures, will be in the nature of a brief summary of the electrical industry as it is today, showing how electricity enters into every-day life, with a glimpse into the future showing its possibilities and the part the central station plays in its development.

PHOTOGRAPHS TRANSMITTED OVER WIRES BY NEW METHOD.

Successful transmission of photographs over ordinary telegraph wire has been demonstrated by Edward Beline, a French scientist. Instead of transmitting by means of dots or lines, he has devised a sending and receiving machine which resembles an old-fashioned phonograph. A photographic plate is made in the form of a cylinder and is traversed by a microscopic beam of light as the old phonograph records were traversed by a needle. The beam of light modulates the electric current which goes out over the wire from the receiving end, and this current similarly modulates a beam of light which is traversing a sensitized cylindrical plate and retraces the picture. The first test which proved a real success took place at the offices of the New York *World* and the St. Louis *Dispatch*.

HYDROELECTRIC PROJECT PLANNED IN SONORA, MEXICO.

An irrigation and hydroelectric project that has for its purpose the reclaiming of about one million acres of land in the valleys of the Sonora and San Miguel rivers and the generating of electric power for transmission to cities, towns and industries throughout the state of Sonora is being promoted by the government of that state. A party of engineers, headed by Nicolas Duran of the City of Mexico, and A. C. Caballero of Nogales, Ariz., are now in the field locating the sites for two big dams and reservoirs that are to be constructed as a part of the project. The land which is to be placed under irrigation is owned by the federal and state governments.

DISCUSS RADIO TELEPHONY AT NEW YORK MEETING.

A paper on "Modulation in Radio Telephony" was presented by R. A. Heising, Western Electric Co., at the meeting of the Institute of Radio Engineers held Dec. 1 in the Engineering Societies building, New York City. The various methods of modulation employed in radio telephony were considered and their usefulness theoretically and practically discussed. The application of one of these systems in the Arlington long-distance radiophone tests was also described by Mr. Heising.

ATHLETIC FIELD TO COMMEMORATE EMPLOYE HEROES.

The Western Electric Co. is planning a ten-acre athletic field at its Hawthorne factory near Chicago to commemorate its 61 employes who sacrificed their lives during the war. In a report circulated by the company regarding the war activities of its personnel it is stated that 7521 were actively engaged in the service during the period of hostilities, 4675 being in the army and 1253 in the navy.

COMING CONVENTIONS.

American Institute of Chemical Engineers. Winter meeting, New Orleans, La., Dec. 6-9. Headquarters, St. Charles Hotel. Secretary, John C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

Illinois State Electric Association. Annual convention, Chicago, Dec. 9. Headquarters, Hotel La Salle. Secretary, R. V. Prather, Springfield, Ill.

Western Association of Electrical Inspectors. Annual convention, Detroit, Mich., Jan. 25-28. Headquarters, Hotel Statler. Secretary, William S. Boyd, 175 West Jackson boulevard, Chicago.

Naional Council of Lighting Fixture Manufacturers. Annual convention and lighting fixture market, Elmwood Music Hall, Buffalo, N. Y., Feb. 14-19. Secretary, Charles H. Hofrichter, 8410 Lake avenue, Cleveland.

National Fire Protection Association. Annual convention, San Francisco, June 14-16. Secretary, Franklin H. Wentworth, 87 Milk street, Boston.

American Institute of Electrical Engineers. Annual convention jointly with the Pacific Coast convention, Salt Lake City, Utah, June 20-25. Secretary, F. L. Hutchinson, 33 West 39th street, New York City.

COMMERCIAL PRACTICE

New-Business Methods, Policies, Rates and Kindred Central-Station Matters for the Man Engaged in Selling Electricity

CULTIVATING GOOD-WILL FOR PUBLIC UTILITY INDUSTRY.

Plan of Illinois Committee on Public Utility Information Favored by Other States, Which Have Inaugurated Similar Campaigns.

The Illinois Committee on Public Utility Information was formed in April, 1919, to conduct a systematic campaign for informing the public on the fundamentals, and particularly the economics, of the public utility industry and thereby endeavor to cultivate a public opinion friendlier both the industry and the companies engaged in it. The committee aims to utilize all possible agencies for getting the case of the utilities before the public. It relies mainly upon newspapers, but it has also developed from time to time systematic utilization of other agencies, including public speakers, pamphlet literature and the public schools.

Observation of the Illinois plan at work has led to the inauguration of similar campaigns in Indiana, Ohio, Kentucky, Missouri, Arkansas, Nebraska and Oklahoma, and the preliminary steps toward doing so have been taken in Michigan, Wisconsin, Iowa, Texas, California and New York. The National Electric Light Association executives have approved the Illinois plan and favor extension of it into every state. The executive committee of the American Electric Railway Association at its meeting in Cleveland last winter also approved the plan and voted to co-operate with other national associations for extension of it.

Personnel of Illinois Public Utility Information Committee.

The committee as now constituted, including the recent appointments, is as follows:

Chairman, John F. Gilchrist, vice-president, Commonwealth Edison Co., Chicago; director, Bernard J. Mullaney, director public relations, Peoples Gas Light & Coke Co., Chicago; associate director, H. M. Lytle, Chicago; members, Martin J. Insull, vice-president, Middle West Utilities Co., Chicago, and president of the National Electric Light Association; Charles A. Munroe, vice-president, Peoples Gas Light & Coke Co., Chicago; Britton I. Budd, president, Chicago Elevated Railways Chicago; John L. Spellman, publicity manager, Chicago Telephone Co., Chicago; George R. Jones, secretary, Public Service Co. of Northern Illinois, Chicago; Williston Fish, vice-president and general manager, Chicago Surface Lines, Chicago, and Stanley R. Edwards, Chicago.

Members representing the Illinois Gas Association: E. H. Negley, manager, Canton Gas & Electric Co., Canton; Ray Stretch, general manager, Union Gas & Electric Co., Bloomington; H. S. Whipple, manager, Rockford Gas Light & Coke Co., Rockford, and W. M. Willett, general manager, Western United Gas & Electric Co., Aurora.

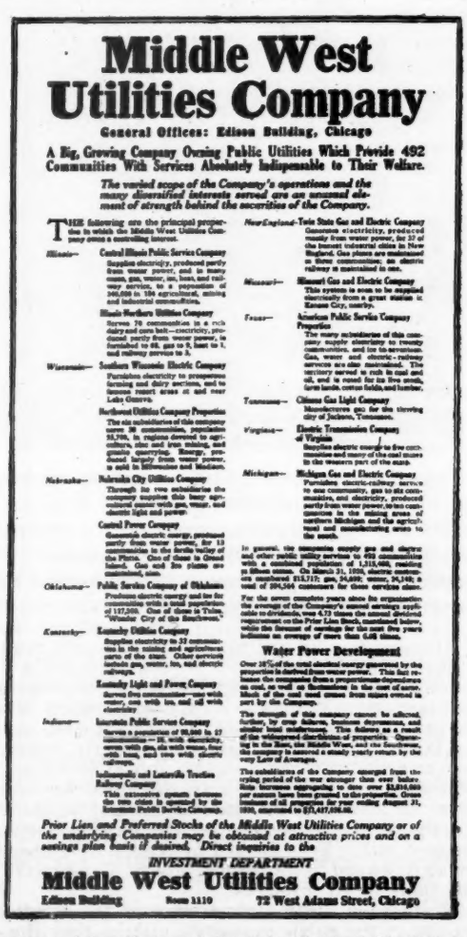
Members representing the Illinois State Electric Association: R. S. Wallace, vice-president and general manager, Central Illinois Light Co., Peoria; B. J. Denman, president, Tri-City Railway & Light Co., Rock Island; Marshall E. Sampsell, president, Central Illinois Public Service Co., Chicago; William A. Baehr, president, Southern Illinois Light Co., Chicago, and R. V. Prather, secretary-treasurer, Illinois State Electric Association, Springfield.

Members representing the Illinois Electric Railway Association: J. R. Blackhall, vice-president and general manager, Chicago & Joliet Electric Railway Co., Joliet; W. H. Sawyer, president, East St. Louis & Suburban Railway Co., East St. Louis; A. D. Mackie, vice-president and general manager, Springfield Consolidated Railway Co., Springfield, and E. E. Soules, publicity manager, Illinois Traction System, Peoria.

Members representing the Illinois Independent Telephone Association: Dr. R. E. Gordon, president, Illinois Independent Telephone Association, El Paso; Jay G. Mitchell, secretary, Illinois Independent Telephone Association, Springfield; C. B. Cheadle, Sterrett-Cheadle Properties, Joliet, and O. F. Berry, president, Mississippi Valley Telephone Co., and general counsel, Illinois Independent Telephone Association, Carthage.

UTILITY COMPANY PRESENTS FACTS TO INVESTORS.

The investment department of the Middle West Utilities Co., Chicago, is using the advertising columns of the local newspapers for the purpose



Middle West Utilities Company

General Offices: Edison Building, Chicago

A Big, Growing Company Owning Public Utilities Which Provide 492 Communities With Services Absolutely Indispensable to Their Welfare.

The varied scope of the Company's operations and the many diversified interests served are an unusual element of strength behind the securities of the Company.

THE following are the principal properties in which the Middle West Utilities Company owns a controlling interest.

Illinois—

Central Illinois Public Service Company
Supplies electricity, produced partly from water power, and in many cases, gas, water, ice, heat, and railway service, to a population of 340,000 in 150 agricultural, mining and industrial communities.

Illinois Northern Utilities Company
Serves 70 communities in a rich dairy and corn belt—electricity, produced partly from water power, is furnished to 68, gas to 9, heat to 1, and railway service to 3.

Wisconsin—Southern Wisconsin Electric Company
Furnishes electricity to prosperous farming and dairy sections, and to famous resort areas at and near Lake Geneva.

Northwest Utilities Company Properties
The six subsidiaries of this company serve 36 communities, population 35,700, in regions devoted to agriculture, coal and iron mining, and quarry quarrying. Energy, produced largely from water power, is sold in Superior and Madison.

Nebraska—Nebraska City Utilities Company
Through its two subsidiaries the company supplies this busy agricultural center with gas, water, and electric light and power.

Central Power Company
Economical electric energy, produced partly from water power, for 13 communities in the fertile valley of the Platte. One of these is Grand Island. Gas and ice plants are operated, also.

Oklahoma—Public Service Company of Oklahoma
Produces electric energy and ice for communities with a total population of 137,500. One of these is Tulsa, "Wonder City of the Southwest."

Kentucky—Kentucky Utilities Company
Supplies electricity to 37 communities in the mining and agricultural parts of the state. Other services include gas, water, ice, and electric railways.

Kentucky Light and Power Company
Serves five communities with gas, water, coal with ice, and all with electricity.

Indiana—Interstate Public Service Company
Serves a population of 50,000 in 27 communities—10, with electricity, seven with gas, six with water, four with ice, and two with electric railways.

Indianapolis and Louisville Traction Railway Company
This extensive system passes into entire control by the Interstate Public Service Company.

New England—Twin State Gas and Electric Company
Generates electricity, produced mainly from water power, for 37 of the busiest industrial cities in New England. Gas plants are maintained in three communities; an electric railway is maintained in one.

Missouri—Missouri Gas and Electric Company
This system is soon to be supplied electricity from a great station at Kansas City, outside.

Texas—American Public Service Company Properties
The many subsidiaries of this company supply electricity to twenty communities, and ice to seventeen. Gas, water and electric-railway services are also maintained. The territory served is rich in coal and oil, and is noted for its live stock, farm lands, cotton fields, and lumber.

Tennessee—Chinese Gas Light Company
Manufactures gas for the thriving city of Jackson, Tennessee.

Virginia—Electric Transmission Company of Virginia
Supplies electric energy to five communities and many of the coal mines in the western part of the state.

Michigan—Michigan Gas and Electric Company
Furnishes electric-railway service to one community, gas to six communities, and electricity, produced partly from water power, to ten communities in the mining areas of northern Michigan and the agricultural and manufacturing areas to the south.

In general, the companies supply gas and electric and other public utility services to 492 communities with a combined population of 1,315,000, residing in fifteen states. On March 31, 1920, electric customers numbered 213,717; gas, 34,600; water, 36,340; a total of 284,564 customers for these services alone.

For the seven complete years since its organization the average of the Company's annual earnings applicable to dividends, were 4.72 times the annual dividend requirements on the Prior Lien Stock, mentioned below, while the forecast of earnings for the next five years indicates an average of more than 6.08 times.

Water Power Development

Over 30% of the total electrical energy generated by the properties is derived from water power. This fact removes the companies from a dependence on coal, or coal, or fluctuations in the cost of same. Much of the coal used comes from mines owned in part by the Company.

The strength of this company cannot be affected, further, by crop failures, business depressions, and similar local misfortunes. This follows as a result of the widespread distribution of properties. Operating in the East, the Middle West, and the Southwest, the company is assured a steady yearly return by the very Law of Average.

The stabilizers of the Company emerged from the trying period of the war stronger than ever before. Gross increases aggregating to date over $2,000,000 per annum have been granted to the properties. Gross business of all properties for year ending August 31, 1920, amounted to $71,447,696.00.

Prior Lien and Preferred Stocks of the Middle West Utilities Company or of the underlying Companies may be obtained at attractive prices and on a savings plan basis if desired. Direct inquiries to the

INVESTMENT DEPARTMENT

Middle West Utilities Company

Edison Building Room 1110 72 West Adams Street, Chicago

Newspaper Advertisement Used by Central Station Company to Tell of Its Activities and Financial Standing.

of acquainting the public with the scope of the company's operations and the diversified interests served by it. Stress is laid on the element of strength behind the securities. The principal properties in which the Middle West Utilities Co. owns a controlling interest are listed, together with other pertinent facts to aid the investor in getting a line on the growth and earnings of the company and its subsidiaries.

CAMPAIGN TO INCREASE SALES OF ELECTRICAL APPLIANCES.

In order to stimulate sales of lamps during September, and thus add to the present demand for and use of service, the Pacific Power & Light Co., Portland, Ore., offered a number of prizes. Last month the company conducted a sales campaign on the Thor washing machine with the same object in view. The company reports that the merchandise sales have decreased during the past few months pretty generally and the present series of campaigns are being conducted to re-establish or better the previous records. Reduced sales records are attributed to the fact that the communities which the company serves have become obsessed with the idea that all prices are on the decline.

READING UTILITY ISSUES DATA ON INDUSTRIES SERVED.

The Metropolitan Edison Co., Reading, Pa., has issued a statement setting forth that out of a total of 567 manufacturing and industrial plants in the Reading district, an aggregate of 87% are using central-station service supplied by the company. The various plants include ironworking establishments, textile mills, hardware factories and other important lines of industry, with a gross production valued at $200,000,000 per annum.

PUBLIC VERSUS PRIVATE OWNERSHIP OF UTILITIES.

Committee of Utility Commissioners Favors Private Ownership With Regulation as Against Public Ownership Without Regulation.

The committee on public ownership and operation of the National Association of Railway and Utilities Commissioners, composed of representatives of the 45 state utilities commissions of the country, in its report made at the recent annual convention in Washington, D. C., said:

"The question of private ownership with regulation as against public ownership without regulation should no longer be considered by intelligent investigators an open question. We think it may be admitted as a general proposition that public ownership and operation has failed wherever it has been properly tested. We recognize the fact that in some special locations public ownership and operation may appear to be successful but we hold that if the real facts might be ascertained and the same test applied to the publicly owned and operated utility as is applied by regulatory bodies to the privately owned and operated utility, the general result will apply in all instances.

"We need no better illustration of the result of the attempt of the public to operate utilities than the recent operation of the railroads by the United States government. The result is common knowledge. They came back to their owners in a broken and disorganized condition.

"Destroy private ownership with public regulation and the next step is government ownership and operation. When that time comes, if it does, our system of government will have to be changed to meet it. We will not be living under the system of constitutional government which we now enjoy because these properties cannot be taken over and honestly paid for through any series of bond issues or otherwise, and operated as efficiently and economically as they are now operated in the hands of their owners. In order to take them over and operate them at a less cost than their owners can operate them, it would be necessary to confiscate all or a large portion of the actual value of these properties and if that could be accomplished it will be notice to the world that our constitution has changed, and that our courts are no longer able or capable of protecting private property from public confiscation."

INSTITUTE ARRANGES EDUCATIONAL COURSE ON ELECTRICITY.

The construction department of the Commonwealth Edison Co., Chicago, has arranged with the Central Station Institute to give a series of 15 lectures to the men of that department. These lectures will cover the principles of magnetism and electricity and the construction and operation of electrical apparatus most commonly met with in construction work. The fact that 132 men have already enrolled shows that the value of such a course is fully appreciated. The first division, consisting of 50 men from the shops, attended the first lecture Nov. 9, which consisted of a demonstration of the principles of magnetism. The second division, composed principally of station installation men, had its first meeting Nov. 16. Arrangements have been made to hold classes on alternate Tuesday evenings. The lectures are being given by F. A. DeLay, of the Central Station Institute.

BID FOR SUPPLYING MUNICIPALITY WITH ELECTRICAL ENERGY.

The Pennsylvania Light & Power Co. has submitted a bid to the city council of Allentown, Pa., for furnishing electrical energy for light and power service for the municipality covering a period of ten years, graded down. For arc lamps the price for ten years is $64 per lamp; for five years, $72; three years, $75; one year, $77 per lamp. For incandescent-lamp service the company bids $19.25, or 6.5 cents per kw-hr. for ten years; $31, or 10 cents per kw-hr. for five years; $38, or 12.1 cents per kw-hr. for three years; $42 per lamp, or 13.4 cents per kw-hr., for one year. The total lighting charge is estimated to cost close to $100,000 during the coming year.

UTILITY COMPANY'S NOVEL WAY OF PROMOTING GOOD-WILL.

As a matter of service, looking toward goodwill, the Merchants Heat & Light Co., Indianapolis, Ind., on Nov. 2, received Associated Press election returns by wires direct into its main office building located at the most central point in the city and in conjunction with the local newspapers, displayed the returns on a screen. The city officials had the street blocked off so there would be no traffic, and it was estimated that from 6000 to 8000 people watched the returns during the evening.

OPERATING PRACTICE

Methods and Problems Embracing Operation and Installation of Power-Plant Equipment and the Distribution of Electrical Energy

LARGEST AUTOMATIC SUBSTATION OPERATED IN CLEVELAND.

Maintenance Crew Particularly Trained to Care for This and Three Additional Stations to Be Installed in the Near Future.

Automatic operation of large rotary-converter substations is now a fact in the installation and operation of a 3000-kw. station by the Cleveland Railway Co. This station, which contains two 1500-kw. Westinghouse rotary converters together with transforming, switching, metering and control equipment, is the first of four stations to be installed to take care of heavy-traffic load outside of the main business section of the city.

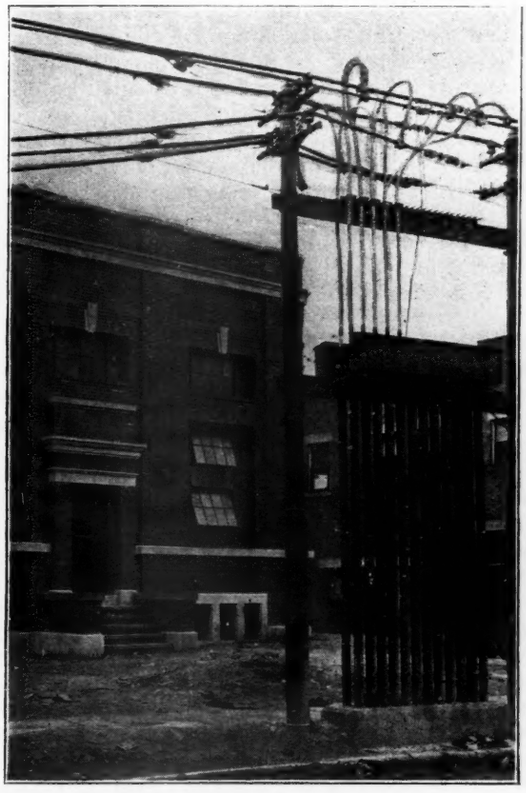
In the past several years there have been a number of automatic substations installed for use in small cities and for interurban lines. No one had attempted to adopt this apparatus for heavy city traffic because it was thought that several of the advantages gained by its use would not be obtained where substations had to be operated continuously a greater part of the 24 hrs. Consequently the installation of full-automatic equipment at Cleveland, the fifth largest city in the United States, is interesting because it shows the wide application of "laborless" equipment. The Heights substation which was recently put in operation by the Cleveland Railway Co. is also distinctive because of its being the largest station with the largest units ever installed whose operation is to be left entirely to automatic operation.

The advantage of this equipment over manually operated apparatus is both in the solving of the labor problem and in the better operation that will be obtained. After the main a-c. circuit-breakers are closed, it takes only about 40 seconds for the entire cycle of operation to be finished so that the machine can immediately assume load. Besides being designed to take care of varying conditions, precautions have been taken to meet all difficulties that can be foreseen. For this purpose there are 18 protective relays, each one functioning as conditions for its use arises.

Maintenance Men Specially Trained.

The new substation is taking care of city load, outside of the two-mile limit of the Cedar substation, and the load of the new Cleveland Interurban Railway Co. line which is being operated by the Cleveland Railway Co. The interurban line extends about two miles beyond the Heights substation so that its load can be easily taken care of. In addition, the station will relieve greatly the load on the Cedar substation which is in the most intensely populated residential section of the city.

The difficulty of obtaining proper maintenance men, sometimes encountered in the installation of automatic substation equipment, was obviated by the Cleveland Railway Co. in a manner that has proven most successful. When the stations were contemplated it was seen that several high-class men were desirable who would be well informed as to the layout of the station in order to properly find trouble and maintain the equipment. For this reason L. D. Bale, engineer of substations, who has spent the past year and a half in the study of automatic operation, picked three likely men and initiated a school wherein he and the men studied very intensively the complete working diagrams and schematic diagrams of the station. Questions were raised as to what would happen if a relay failed to operate, or if certain conditions were present, and the answers were obtained by actually working through the circuits. In addition, a separate wiring diagram was made for each piece of apparatus so that in case of trouble the exact cause could be located with the least difficulty and in the quickest possible manner.



View Outside of Substation Showing Arrangement of Outgoing Feeders.

Equipment for the four automatic substations was designed by the engineers of the Westinghouse Electric & Manufacturing Co., working in conjunction with the engineers of the Cleveland

Railway Co. In this connection it is to be observed that the practical experience of the operating company proved to be of no little value to the designing engineers. In numerous instances the engineers of the operating company were able to point out the need for protective devices and relays to provide for various operating contingencies. The manufacturer forthwith designed and constructed the apparatus with which to meet these needs.

PLANT CAPACITY INCREASED BY USE OF SUPERHEATED STEAM.

Pipe-Line and Cylinder Condensation Reduced and Pressure Reductions Compensated for by Superheating.

The limitations of capacity continually bring up new problems for solution by the operators and management of every power plant. Where not already in use, the installation of superheaters will often be found to offer a ready solution in many cases. The use of superheated steam will result in a reduction in the amount of steam required by an engine, this reduction being due to the greater amount of heat delivered per pound of steam, the better quality of steam delivered, and the reduction in cylinder condensation. The decrease in steam consumption, where superheat is used, results in a steam reserve which can be utilized in the engine to take care of its overload capacity.

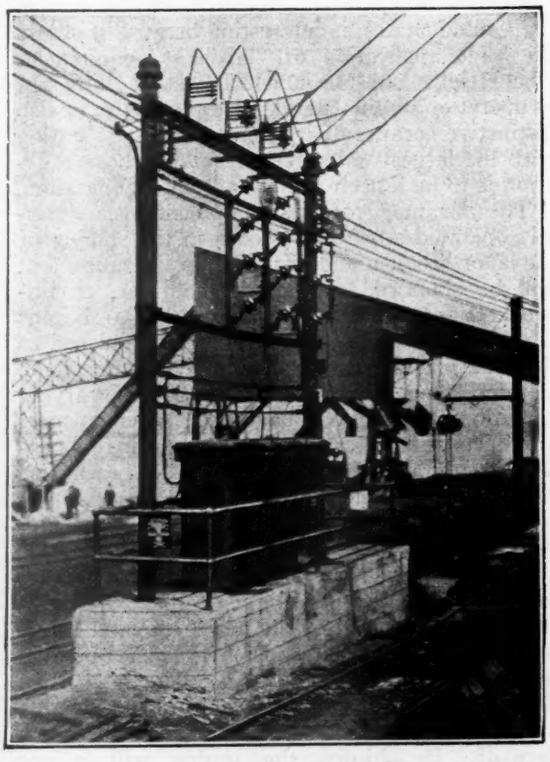
There are still other points in connection with plant capacity that logically come up in considering the factors which govern the use of superheated steam. Cases arise at frequent intervals where, because of the condition of a boiler, the insurance company requires that it be operated at a lower pressure. Loss in capacity results from the reduction of pressure, and the plant management faces the necessity of installing a new boiler. Superheating makes up the loss in boiler capacity when a plant is forced to reduce the boiler operating pressure. Furthermore, the engine operating on superheated steam may under certain conditions furnish more power even under a reduced pressure than it would if using saturated steam.

The problem of reduced condensation in long pipe lines is one which is faced in many plants. In the generation of steam 90% of the heat necessary to evaporate water is latent heat of evaporation. When steam is condensed without doing work the latent heat is liberated and wasted. Condensation in long pipe lines represents a waste of 90% of the heat required to evaporate it. Superheat is necessary to raise the temperature of the steam to a point where all of the steam can be transmitted to its destination without condensation losses. The heat loss in transmitting superheated steam in covered pipe is often actually less than with saturated steam because superheated steam does not give up its heat as readily as saturated steam. Aside from this, more heat can be taken from superheated steam before condensation begins.

Regardless of other factors entering into a consideration of the use of superheated steam, the factor of first cost will undoubtedly always be considered. In considering this point it must be borne in mind that it is essential that all the conditions in a plant be carefully studied by a competent person who should render an unbiased and accurate opinion as to the merits of superheating. In this way the plant owner can know with certainty just what returns he can expect from his investment. It is not a question which can be answered in general by the size or type of plant, but depends entirely on the conditions which exist or which are desired in the plant, whether or not the plant owner is justified in going even to nominal expense in the installation of superheaters. The possible economies attending the use of superheated steam depend on how far a plant is already economically developed. In many cases installations are known to have paid for themselves in a short period of operation.

SUBSTATION INSTALLATION WHERE SPACE IS LIMITED.

For operation of small capacity mines, purchased power is of advantage especially when the space is so limited that the ground area occupied by a local power plant would be of value. The particular mine served by the substation shown in the accompanying illustration has a capacity of from 800 to 1000 tons of coal per day. The unit-type switch and protective equipment consists of high-speed sphere gap, graded-resistance lightning arresters with combination choke coils, disconnecting switches and fuses supplied by the Delta Star Electric Co., Chicago. The insulators are normally rated at 27,000 volts with a flash-over capacity of 100,000 volts, thus giving the high factor of safety needed in locations where the insulators are subject to heavy dust deposits.



Outdoor Substation Rated at 300 kv-a. and 6600 Volts.

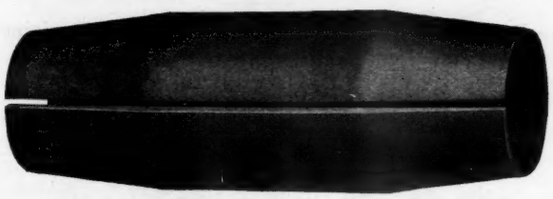
CONTRACTING-CONSTRUCTION

A Department Devoted to Various Problems Relating to the Installation, Operation and Maintenance of Electrical Equipment

MAKING JOINTS IN LEAD-COVERED LIGHT AND POWER CABLE.

Good Workmanship and Materials Required to Produce Joints That Give Lasting Satisfaction in Service.

Almost anyone who can use a blow torch can make a cable splice, or rather what looks like a joint, but good and sufficient materials and a high degree of knowledge and skill are required to



Typical Copper Connector for Cable Splice.

make a joint that can be relied upon to give service. Joints are the weakest spots in a cable system, even when well made, and too much care and attention cannot be given to their construction. Accompanying tables show the sizes of sleeves, quantity of filling compound, quantity of wiping solder and dimensions of copper connectors required to make up various joints according to the recommendations of the Standard Underground Cable Co., Pittsburgh.

Copper connectors play an important part in joint making, and careful consideration should be given to their selection. Connectors should be made of high-conductivity copper, and thoroughly annealed so that they may be easily closed tight around the conductors. The ends should be beveled so as to avoid sharp edges and thus prevent static or corona discharges. This is an especially important feature in the jointing of high-voltage cables. A slot should be cut along the entire length of the connector to allow the solder to flow freely into and around the connector and the cable strands and to permit a thorough mechanical connection before soldering. Tinning will greatly facilitate soldering.

Dimensions of all connectors shown in the table are such as to make the cross-sectional area, and therefore the conductivity, equivalent to that of the conductors which they connect, and also to give an ample area of contact between the conductor and connector. If an inferior grade of copper is used, heavier connectors will be required. However, economy dictates that the best grade of copper be employed in order to reduce the amount of insulation, compound, etc., used as well as to insure the best possible joint.

TABLE SHOWING COPPER-SLEEVE DIMENSIONS FOR VARIOUS SIZES OF SOLID AND STRANDED CABLE.

Size Conductor (B. & S. gauge) or Cir.-mils.	No. Strands.	Diameter in ins. Inside.	Diameter in ins. Outside.	Thickness in ins.	Length in ins.	Weight per 100 connectors in lbs.
6	Solid	.166	.260	3/64	2	1.9
5	Solid	.185	.279	3/64	2	2.0
4	Solid	.208	.333	1/16	2	3.3
3	7	.266	.391	1/16	2	4.2
2	7	.298	.423	1/16	2	4.6
1	19	.339	.464	1/16	2	5.1
0	19	.381	.537	5/64	2	7.2
00	19	.428	.584	5/64	2	8.0
000	19	.480	.668	3/32	2	11.0
0000	19	.539	.727	3/32	2¼	15.0
250,000	37	.587	.806	7/64	2¼	17.0
300,000	37	.643	.862	7/64	2½	21.0
350,000	37	.695	.945	1/8	2½	26.0
400,000	61	.744	.994	1/8	2¾	30.0
450,000	61	.789	1.070	9/64	2¾	36.0
500,000	61	.831	1.112	9/64	3	41.0
550,000	61	.872	1.153	9/64	3	43.0
600,000	61	.911	1.224	5/32	3	54.0
650,000	61	.948	1.261	5/32	3	56.0
700,000	61	.984	1.297	5/32	3	58.0
750,000	61	1.018	1.393	6/32	3½	80.0
800,000	61	1.051	1.426	6/32	3½	82.0
850,000	61	1.082	1.457	6/32	3½	88.0
900,000	61	1.115	1.490	6/32	3½	91.0
950,000	61	1.146	1.521	6/32	3½	95.0
1,000,000	61	1.180	1.555	6/32	4	103.0
1,250,000	91	1.320	1.758	7/32	4½	164.0
1,500,000	91	1.440	1.878	7/32	5	185.0
1,750,000	127	1.560	1.998	7/32	5½	230.0
2,000,000	127	1.670	2.170	8/32	6	300.0
2,500,000	127	1.824	2.324	8/32	6½	345.0

LEAD SLEEVES, SOLDER AND COMPOUND REQUIRED FOR STRAIGHT SINGLE-CONDUCTOR CABLE JOINTS—6600 VOLTS OR LESS.

Outside Cable Diameter in ins.	Lead Sleeve Diameter, ins.	Lead Sleeve Length, ins.	Compound in gals.	Wiping Solder in lbs.
0.550.....	1.0	8	.05	.8
0.551 to 0.950.....	1.5	10	.1	1.5
0.951 to 1.350.....	2.0	12	.2	2.5
1.351 to 1.750.....	2.5	12	.3	3.8
1.751 to 2.150.....	3.0	14	.5	5.0
2.151 to 2.550.....	3.5	16	.6	6.1

LEAD SLEEVES, SOLDER AND COMPOUND REQUIRED FOR STRAIGHT SINGLE-CONDUCTOR CABLE JOINTS—OVER 6600 VOLTS.

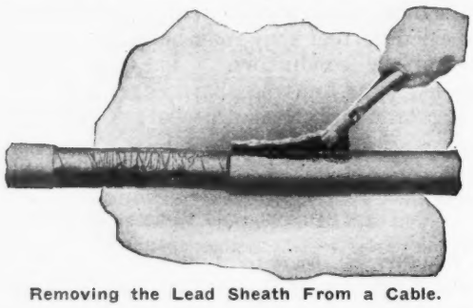
Outside Cable Diameter in ins.	Lead Sleeve Diameter, ins.	Lead Sleeve Length, ins.	Compound in gals.	Wiping Solder in lbs.
0.550.....	1.0	10	.05	.8
1.551 to 0.950.....	1.5	12	.10	1.5
0.951 to 1.350.....	2.0	14	.2	2.5
1.351 to 1.750.....	2.5	16	.4	3.8
1.751 to 2.150.....	3.0	18	.6	5.0
2.151 to 2.550.....	3.5	18	.8	6.1

Moisture Must Be Excluded From Joints and Materials Used.

Moisture in the material of the cable itself, or on and in the copper connectors, tapes, insulating tubes and lead sleeves must be thoroughly removed and thereafter kept away if a satisfactory joint is to be made. Moisture may result from many causes such as perspiration on the hands of the jointer, drippings from the wall or roof of the manhole or room in which the joint is made, or from condensation in a damp atmosphere upon the materials and tools used in jointing and on the cable itself. Moisture may be guarded against by having the jointer keep his hands dry, by pro-

tecting the joint against drippings and by warming the tools and materials to a temperature which will prevent condensation.

A convenient method of protecting the tapes or other fibrous insulating materials against moisture in the air is to have a covered metal box filled with transformer oil in which they can be immersed. The small tools may also be immersed in a similar manner. Peculiar local conditions may produce dangers from moisture from other sources than those mentioned. These conditions should be carefully studied and methods provided for guarding against their bad effects.

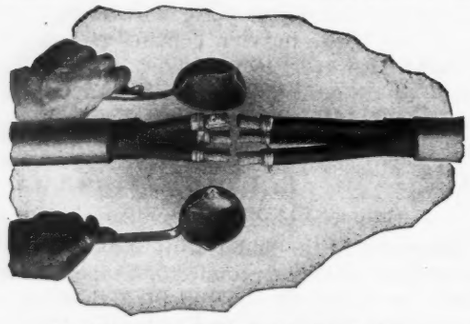


Removing the Lead Sheath From a Cable.

After the interior of the cable and the copper connectors, tapes, tubes, etc., used in making the joints have been exposed to the atmosphere, all operations should be carried through as rapidly as possible consistent with good reliable workmanship. A little care in this direction will greatly reduce the opportunity for the entrance of moisture into the joint. When the joints are made on a cable installed directly in a trench, as in the case of armored cable, a large roomy excavation should be made where the joint is to be installed and the bottom and sides of this excavation covered with a good sized tarpaulin or piece of clean canvas to prevent dirt from getting on the jointing material.

LEAD SLEEVE, SOLDER AND COMPOUND REQUIRED FOR STRAIGHT MULTIPLE-CONDUCTOR CABLE JOINTS—ALL VOLTAGES.

Outside Cable Diameter in ins.	Lead Sleeve Diameter, ins.	Lead Sleeve Length, ins.	Compound in gals.	Wiping Solder in lbs.
0.800.....	1.5	14	.20	1.4
0.801 to 1.200.....	2.0	16	.25	2.2
1.201 to 1.600.....	2.5	16	.35	3.3
1.601 to 2.000.....	3.0	18	.6	4.5
2.001 to 2.400.....	3.5	18	.8	5.7
2.401 to 2.800.....	4.0	18	1.0	6.8
2.801 to 3.200.....	4.5	20	1.4	7.4



Heating and Tinning the Conductors.

The removal of the lead sheath should be performed in such a manner as to absolutely prevent any cut or indentation in the insulating belt underneath. Lead cutters or chipping knives should be used so as to cut the lead without producing an indentation in the underlying insulation. The belt insulation should also be carefully removed and cleanly cut so as to avoid any cutting of the insulation on the conductor, and finally, in taking off the insulation from the conductor, strict attention should be paid by the jointer so that no cuts or nicks are made on the bare copper conductor. Solder and insulating compound, as well as the pots and kettles in which they are melted, should be carefully watched to avoid the presence and accumulation of dirt and foreign matter of any kind in these very important materials. The slightest amount of foreign material in the compound or on the tape, connectors or sleeve may ruin an otherwise good joint.

ELECTRICAL INSPECTION DEPARTMENT INTERPRETS RULES.

Rule Allowing Use of 1320-Watt Circuits Explained and Definite Regulations Regarding Its Use Are Given.

The Bureau of Electrical Inspection of the city of Chicago has found it necessary to interpret the meaning and intent of the rule allowing the use of the 1320-watt circuit in that city. The interpretation, as given in the *Bulletin* of the bureau, is as follows:

"The rule on branch circuits reads: 'By special permission, in cases where wiring equal in size and insulation to No. 14 B. & S. gauge standard rubber-covered wire is carried direct into keyless sockets or receptacles, and where the location of sockets and receptacles is such as to render unlikely the attachment of flexible cords thereto, the circuits may be so arranged that not more than 1320 watts (or 32 sockets or receptacles) will be dependent upon the final cutout.'

"A recent investigation of 122 cases where special permits had been granted for 1320-watt circuits showed that there were violations in 22 instances, or 18%. Of these violations, 21 were caused by the addition of flexible cords to the circuits and one by an extension to the circuit (without permit) where drop lights had been installed.

"The following general rules have been formulated for the guidance of the inspector. It may be necessary in special cases to modify some of these rules, in which case the matter should be taken up with the chief inspector:

"(1) In each case, before a special permit will be issued for 1320-watt circuits, the contractor must make a written request by letter, and the inspector must investigate the conditions and recommend the issuance of the permit.

"(2) Permission will not be granted for 1320-watt circuits for the general or complete wiring of a building, unless the inspector can satisfy himself that the restrictions herein given as to the probable use of flexible cord can be fully complied with.

"(3) Permission will be granted for 1320-watt circuits on show-window lighting only where there is an outlet in the lower part of the window, which outlet is connected to a circuit of 660 watts. This latter outlet is intended to be used for attaching temporary display devices.

"(4) Permission will not be granted for 1320-watt circuits in machine shops or similar locations where light is required close to the work, unless lights are also placed for the individual machines or, unless there are outlets close to the floor connected to 660-watt circuits, these latter outlets to be used for the connection of portables.

"(5) The same general ruling shall apply to office lighting where 660-watt circuits must be provided for desk lights and fans.

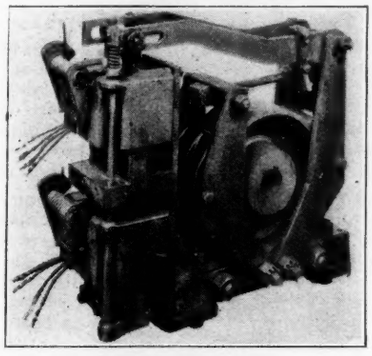
"(6) Permission for 1320-watt circuits will not be granted in other locations unless the inspector can satisfy himself that the use of flexible cords is unlikely."

NEW APPLIANCES

Newly Developed and Improved Electrical and Mechanical Apparatus, Appliances and Devices Now Being Placed on the Market

Solenoid Brakes to Control Induction-Motor Speed.

The use of solenoid brakes for the speed control of induction motors on cranes and hoists has been greatly extended due to their recent application in connection with other forms of electric braking. The two forms of brake, as developed by the General Electric Co., Schenectady, N. Y., are the multiple-magnet and the solenoid load brake. The former is simply two solenoid brakes combined to form a single brake actuated by two or more independent magnets. The multiple system is used to give gradations in the speed control, being particularly adaptable to apparatus which moves in a horizontal direction. As each solenoid is de-energized a fraction of the braking torque is applied until enough has been de-energized to bring the apparatus to a full stop, the number of magnets used depending upon the conditions of service.



Close View of Solenoid Brake, Showing Mechanism.

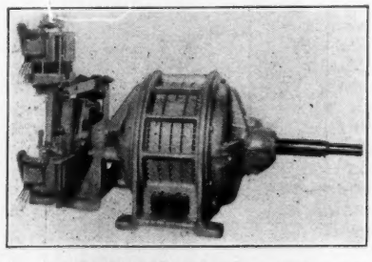
There are several methods of applying remote control to this system of braking. First, both solenoids will be set when the controller is in the off position, but will be energized and de-energized simultaneously when power is applied to the motor. In order to obtain a gradation in braking, one of the cores is retarded from falling for a few seconds by means of a dashpot. The second method is to have both magnets set on the off position of the controller. On the first step of the controller one of them is energized, and on the second step the other is energized and power is applied to the motor. It is desirable to use a dashpot with this method so that in case of a sudden loss of power, or accidental movement of the controller, the full power of the brake will not be applied suddenly.

In the third method, as in the other two, both solenoids are set when the controller is in the off position, the difference being that on the first step one magnet is de-energized, on the second step the second, and on the third step power is applied to the motor. This method gives one point where there is neither power on the motor nor any braking effect, making a coasting point. This coasting point is valuable on high-speed trolleys, in assisting the operator to stop his carriage at a given point. He can allow it to coast almost to the exact spot and then apply the brakes to bring it to a full stop.

Multiple-magnet braking is adaptable to cranes such as revolving hammer heads, traveling gantry cranes, and fast trolleys with swinging loads. In the first instance two degrees of braking are required to save trouble from back lashing in the gears. With the gantrys it is desirable to have a brake strong enough to prevent the crane being blown along the track, but still to have a degree of braking for use in ordinary circumstances that is not strong enough to produce undue shock to the machinery.

The solenoid load brake is designed for the control of induction crane-hoist motors used where a number of varieties of loads are handled by the same hoist. This load brake consists of two solenoids, one in the stator circuit of the motor and the other in the rotor circuit. The former is light enough so that very little braking action is obtained from its operation. If the latter is de-energized, however, it applies heavier weight to the braking levers and consequently increases the braking effect. Since it is in the rotor circuit, its operation depends directly on the voltage in the rotor. Consequently, when the motor is standing still, and there is a high induced voltage in the rotor, the weight of the solenoid is almost raised from the brake levers and practically no braking torque is exerted. But as the speed of the motor increases, and the induced voltage in the rotor decreases, the solenoid holding magnet is gradually de-energized until at full speed there is only a low voltage in the rotor and a greater amount of braking is obtained.

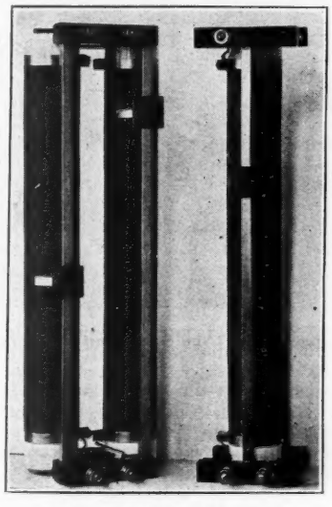
Further remote control of the braking is obtained by inserting a resistor in series with the rotor and the brake magnet, and adjusting the resistor through the controller. Even further variation in the braking can be obtained by adjusting the regular control resistor in the rotor circuit so that the motor itself pushes to some extent against the friction brake. The combination of these methods makes it possible to obtain any desired speed below synchronism with one controller handle. An a-c. crane equipped with this type of brake compares favorably in operating characteristics with a d-c. crane equipped with an automatic mechanical load brake or dynamic braking. It will give better results on creeping speeds when lowering loads than the automatic mechanical system, because its adjustments do not change due to wear. In addition, there is no friction wear when lowering loads.



Solenoid Brake Attached to Shaft of Induction Motor.

Sliding-Contact Tube Rheostat.

The "Standco" sliding-contact rheostats, made by Herman H. Sticht & Co., 15 Park Row, New York City, are said to embody distinct improvements over similar equipment manufactured previously. They may be used in either a horizontal or vertical position, taking the place of the table, switchboard or vertical units. There are three types of each of two models now being marketed, making an assortment of six styles.



Sliding-Contact Rheostats.

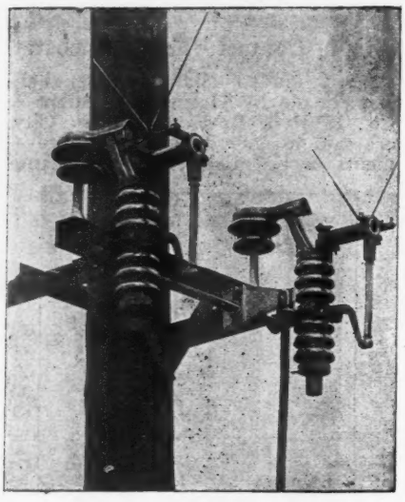
Standard units are made with a total resistance of from 0.4 to 6000 ohms, the low-resistance units having a current capacity of 25 amperes and the high-resistance unit having a capacity of 0.2 amperes. These current ratings correspond to a temperature rise of 200 deg. C. when in continuous service. Corresponding ratings for a temperature rise of 150 deg. C. are 18.6 and 0.15 amperes.

Compact Switching Equipment for Farm Lines.

For the control and protection of small outdoor distributing transformer installations, which supply energy to farm extension lines and the like, the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., has placed upon the market the type FL switch which consists of a combined fuse, lighting arrester and disconnecting switch.

The equipment may be mounted near the top of a line pole so that it is operated from the ground by means of an operating handle. This switch is adapted for applications requiring 24-hour service, but it is also suitable for applications such as grain elevators, mines, quarries, brickyards, etc., which are only operated periodically.

This combination switching equipment is of rugged construction, and all metal parts exposed to the weather have a durable galvanized finish. The pillar-type insulators are made of a single piece of porcelain. The fuse is of the expulsion type, and is mounted in the hollow center of the large pillar-type porcelain insulator. The fuse consists of a casing with contacts at each end,



Compact Pole-Type Switching Equipment.

between which the aluminum fuse wires are connected. The unit may be removed from the inside of the porcelain insulator by giving the metal cap at its lower end a quarter turn. The metal cap is provided with a bayonet form of catch which locks the fuse securely in place. An indicating device which is provided with the fuse drops and hangs suspended from the bottom of the unit when the fuse is blown. This indication can be seen from the ground, and, therefore, obviates considerable pole climbing.

The lightning arrester operates on the horn-gap and series-resistance principle. The spacing of the gap between the brass horns may be varied by means of set screws. The length of the horns is ample to insure positive interruption and dissipation of the arc, and the value of the series resistance is so chosen as to limit the discharge current to a value that can be easily and quickly interrupted by the horn gap and is low enough to insure sufficient freedom of discharge. The series resistance consists of a special composition carbon rod with ferrule-type contacts on each end.

The switch is operated from the ground by means of a handle which can be secured by a padlock in either the open or closed position. This operating handle by means of a pull rod, bell crank and common operating shaft opens or closes all pole units simultaneously. The operating handle is well insulated from the operating shaft by means of an insulating link, and the metal framework of the switch is solidly grounded. The moving contact is attached to the upper end of the pillar-type insulator and makes a self-cleaned sliding contact on the under side of the sleet hood, thus protecting the stationary contact.

These switches are made in both single-phase and three-phase styles for 2500, 6600 and 13,200-volt service. They are intended for applications up to approximately 50-kv-a. rating.

Sterilizer for Instruments and Dressings.

The Prometheus Electric Co., New York City, has developed an electrically heated combination sterilizer. Heaters are made for 110 and 250 volts, and are arranged with fusible members to open the circuit in event of excessive heating resulting from the absence of liquid. Separate compartments are provided for instruments and dressings.

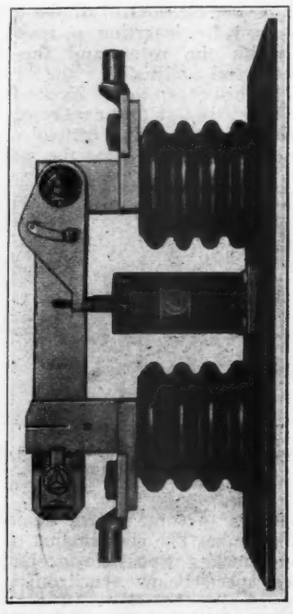
Amplifier and Detector of Small Dimensions.

A single-stage amplifier of unusually small dimensions has been developed by the Acme Apparatus Co., Cambridge, Mass. The equipment is so arranged that a detector and two-stage amplifier can be arranged with little difficulty. Over-all dimensions of the equipment are 3.5 ins. by 3.5 ins. by 5.5 ins. without the vacuum tube and batteries.

Disconnecting Switch with Extra Indicator Contacts.

It is often important to provide for the indication at some remote point of the position of a disconnecting switch. Such an indication is often of value at the point of control of circuit-breakers in series with the disconnect, and serves as a positive check on visual inspections that have been made previously. The unit-type disconnecting switch shown in the accompanying illustration has been developed by the Delta Star Electric Co., Chicago, to fill the demand for such equipment.

As may be seen from the illustration, a separate insulating tube serves to provide for the making of an auxiliary

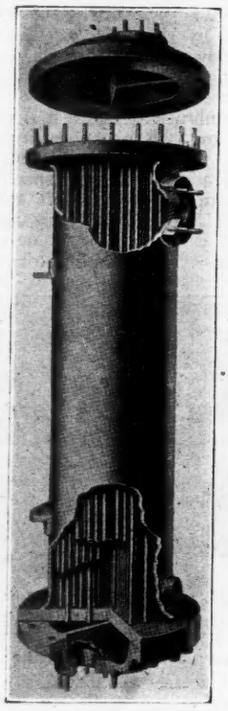


Unit-Type Disconnecting Switch.

contact with a small switch operated by the main blade. This secondary contact closes and opens the circuit of the signal lamps located at the distant point or points. The circuit through the auxiliary switch is not fully closed or opened until the main switch blade is in a fully open or closed position. A positive safety lock prevents the accidental movement of the disconnect after it has been properly set.

G-R Straight-Tube Oil Heater.

The Griscom-Russell Co., 90 West street, New York City, manufacturers of the well-known Reilly oil heater of the coil type, have recently placed on



Preheater for Fuel Oils.

the market a new oil-heater unit of the straight-tube type. This is to supplement their coil-heater line and is known as the "G-R Oil Heater."

This heater, shown in accompanying illustration, is designed for the preheating of fuel oil before it goes to the burner and to insure complete atomization of the oil and perfect combustion under boilers or in furnaces. The oil is pumped through the tubes, and high-pressure steam in the shell serves as the heating medium. The shell of the heater is constructed of wrought steel welded to steel tube plates. Tubes are of seamless drawn steel expanded into tube sheets at either end. Form sheet 167, published by the manufacturer, describes the heater and gives various details of construction.

Adjustable Ground Clamp.

An adjustable ground clamp of improved design has been placed on the market by the Gillette-Vibber Co., New London, Conn. This new clamp, called the "Gee Vee," is made in three sizes to accommodate 3-in. or smaller pipe. Tinned copper is used in the construction of the clamp, and a bolt serves to tighten and secure the contact.

ACTIVITIES IN THE TRADE

Business Developments, Sales Agencies, Trade Literature and Miscellaneous Items Concerning Electrical Manufacturers and Allied Business Interests

Hunter Fan & Motor Co., manufacturer of electric fans, has moved into new offices at 46 West 46th street, New York City.

Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., in leaflet 1910 illustrates and describes its electric drive for cotton openers and pickers.

North American Storage Battery Co. plans to erect a plant at 40 West Pratt street, Indianapolis, Ind., for the manufacture of starting and lighting batteries for motor cars and batteries for electric cars.

Eclipse Electric Machinery Co., Madison and 31st streets, Louisville, Ky., is planning the erection of a plant for the manufacture of electrical equipment to cost about $25,000. Charles E. Willey is president of the company.

Marble-Card Electric Co., Gladstone, Mich., has issued bulletin No. 200 describing in detail its line of direct-current commutating-pole ball-bearing motors, which are built in sizes from 0.5 to 60 hp. for standard voltages and speeds.

Superior Electric Co., Pittsburgh, manufacturer of electrical specialties, has leased a three-story building at 8 South Sixth street, Philadelphia, for a term of years. Improvements will be made in the structure, which will be used as a branch works.

Economy Fuse & Manufacturing Co., Chicago, has announced that C. B. Merrell, who has been connected with the general offices of the company for a number of years, has been appointed district sales manager of the Philadelphia office, 523 Widener building, to succeed E. J. Watson, who has resigned.

Majestic Electric Development Co., 656 Howard street, San Francisco, manufacturer of "Majestic" electric appliances, is conducting an extensive advertising campaign in behalf of its electric heaters in 24 cities west of Chicago through the medium of newspapers. In San Francisco the company plans to run a billboard campaign.

Booth Electric Furnace Co., 326 West Madison street, Chicago, has published a bulletin descriptive of its rotating electric furnaces. While this type of equipment has been largely used for brass melting, a number of furnaces are now in operation melting iron and steel and other metals requiring higher melting temperatures.

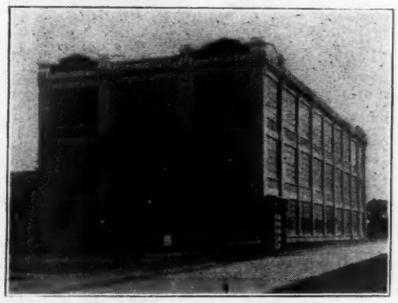
Morse Chain Co., Ithaca, N. Y., announces the opening of a branch factory at Detroit, which will be devoted exclusively to the manufacture of Morse automobile silent chain sprockets and the Morse adjustment. The automobile sales and engineering offices of the company, formerly at 1003 Woodward avenue, Detroit, are now located at the Detroit factory, Eighth and Abbott streets.

Harvey Hubbell, Inc., Bridgeport, Conn., has issued loose-leaf bulletin sheets Nos. 16-13, 16-18 and 16-19, covering pull socket current taps, Hubbell toggle snap switches and "Paraline" convertible plug cap and attachment plugs, respectively.

Benjamin Electric Manufacturing Co., Chicago, has issued a folder descriptive of the Benjamin-Starrett panelboards and cabinets for standard arrangements of bus bars and main connections and adaptable for increased mains, sub-feeds and through-feeds.

Ford, Bacon & Davis, engineers, 115 Broadway, New York City, who have been engaged to determine the value of the property of various street-railway and traction companies of New Jersey with the object of obtaining a basis for the fixing of rates under the existing laws, have issued a booklet containing the law authorizing this determination and excerpts from editorial comment on the subject.

De Laval Steam Turbine Co., Trenton, N. J., manufacturer of centrifugal pumps, steam turbines and speed gears, is one of the leaders in the recent welfare movement among employes as a means of keeping them satisfied and working at maximum capacity. In planning its welfare work



New Patent Office and Record Building of DeLaval Steam Turbine Co.

the company recognized that sports would draw the interest of a large majority of the employes, and an athletic association was formed and a field was laid out for baseball, tennis and other outdoor sports. During the winter the association holds monthly dances and social gatherings. The conditions in and around the plant are all conducive to creating a contented atmosphere and frame of mind among the 800 employes. The buildings, which have a floor space of over 250,000 sq. ft., are light and airy, well ventilated, and spacious. The De Laval company was established in 1901 and the original plant building is still occupied, although it has been modernized and added to as the business expanded. Within the past year a three-story stone structure, 60 by 190 ft., has been erected to provide increased manufacturing facilities.

Simplex Electric Heating Co., Cambridge, Mass., has arranged in loose-leaf form a number of bulletins descriptive of the various electrical household devices which it manufactures, such as flatirons, heating pads, toasters, radiators, cooking ranges, water heaters, baking ovens, portable soldering irons for lamp-socket use, etc.

Esterline Co., Indianapolis, Ind., engineer and manufacturer of graphic meters and permanent magnets, has announced the appointment of the J. W. Murphy Co., 108 South LaSalle street, Chicago, as district representative in the Chicago territory. J. W. Murphy has been the sales manager of the Esterline Co. for a number of years.

Electric Storage Battery Co., Philadelphia, held a convention of its Northwest "Exide" distributors at Minneapolis, Minn., recently. More than 100 representatives, operating "Exide" service stations in the territory covered by the company's Minneapolis branch office, attended. Inspection of one of the giant "Exide" storage batteries operated by the Minneapolis General Electric Co., was a feature of the convention. The batteries inspected are kept in reserve by the Minneapolis General Electric Co., and are capable of carrying the entire downtown load for 15 min., thus protecting the lighting service of the Minneapolis business district in time of an emergency. P. G. Downton, manager of the Minneapolis branch, presided during the sessions, and among the speakers were T. W. Hearne, factory representative, and Godfrey H. Atkin, western district manager.

Cutler-Hammer Manufacturing Co., Milwaukee, in a 16-page catalog entitled "Control of Motor Car Lighting," and known as publication 861, describes the standard and pony lines of C-H automobile lighting switches. Wiring diagrams are given illustrating eight different control combinations for lights that may be obtained by these switches. The switches are described as having large wiping contact surfaces with contactor floating on the operating shaft so vibration and side strain on the button does not cause the lights to flicker. The switches may be arranged horizontally or vertically in gangs of from one to four, with one plate covering all. The advantages of automatic gear changing over the direct hand-lever method, and the prediction that the latter will some day be obsolete, are given in a feature article which appeared in the July 31 issue of "Automobile Topics." This article, in which special mention is made of magnetic-gear shifting as accomplished by the C-H magnetic gear shift, is reprinted in the form of a 16-page leaflet as publication 858, entitled "Your Car and Its 'Wobble-stick'."

PERSONAL MENTION

Biographical Sketches and Chronicle of Changes in Business Connections, Promotions and Other Personal News of the Industry

JOHN KELLY, vice-president and general sales manager of the Edison Storage Battery Co., Orange, N. J., has resigned.

ARTHUR L. WILLIS, formerly connected with Stone & Webster, Inc., New York City, has become associated with McClure, Jones & Reed.

G. W. MUENCH, master electrician of the Triangle Electric Co., Seattle, Wash., has been promoted to the position of manager of the company.

CHARLES S. SPAULDING, for the past two years manager of the municipal electric plant at Wakefield, Mass., has resigned, effective Dec. 1.

MASON H. LYTLE, superintendent of the Piqua (O.) district of the Dayton Power & Light Co., Dayton, O., has resigned to enter another line of work.

H. L. BALL has been appointed sales manager of the Requa Electrical Supply Co., Rochester, N. Y. He was formerly connected with the Rochester Electrical Supply Co.

REGINALD TRAUTSCHOLD, who is a well-known contributor to the trade press, has been placed in charge of the activities of the Society for Electrical Development in connection with trade press articles.

RICHARD TOAS, Portland, Me., representative of the bond department of H. M. Byllesby & Co., Chicago, is moving into larger quarters on the first floor of the Union Mutual building, at 396 Congress street.

ROBERT W. HOY, who was formerly commercial manager of the Elmira Water, Light & Railroad Co., Elmira, N. Y., has accepted a position with the Pennsylvania Power & Light Co., Allentown, Pa., as sales manager.

ELMER E. BUCHER has been appointed commercial engineer in the commercial department of the Radio Corp. of America, with headquarters in New York City. He will have direct charge of sales of radio apparatus to foreign, governmental, miscellaneous and amateur fields.

J. W. LYNCH, superintendent of the plant of the Philadelphia Suburban Gas & Electric Co., at Pottstown, Pa., has resigned, effective Dec. 1, to become manager of the Hagerstown Light & Heat Co., succeeding R. C. Saylor, resigned. Mr. Lynch was formerly manager of the Bucks County Public Service Co., Newtown, Pa.

J. E. SLIMP has been appointed manager of sales of the E. T. Chapin Co., manufacturer of western red cedar poles, piling and posts, Spokane, Wash. He will maintain offices at 127 North Dearborn street, Chicago. Mr. Slimp has been selling supplies and equipment to electric transmission and electric railway companies for the past 20 years and is well known in the district to be covered by his office, which will include the territory east of the Dakotas, Minnesota and the section east of Winnipeg in Canada.

ERIC ZACHAU, formerly in the sales office of Manning, Maxwell & Moore, Inc., Pittsburgh, has been appointed chief engineer of the Shaw Electric Crane Works, Muskegon, Mich., to succeed A. V. Light. Prior to his connection with the Pittsburgh firm Mr. Zachau spent about 12 years as electrical engineer at the Shaw factory.

S. L. WHITESTONE, who has been elected comptroller of the General Electric Co., Schenectady, N. Y., to succeed C. E. Patterson, recently advanced to a vice-presidency in charge of accounting,

S. L. Whitestone.

has been in the company's employ for the past 33 years. He became general auditor in 1911, having previously filled the position of assistant general auditor and traveling auditor. Mr. Whitestone has been associated with the General Electric organization since its inception and before the present company was organized was connected with the Sprague Railway & Motor Co. in 1887 and with the Edison General Electric Co. in 1890. He will therefore bring to his new position an extensive experience in accounting matters extending over a wide period of years. L. D. LeFevre has been elected general auditor to succeed Mr. Whitestone. The new general auditor came to the General Electric Co. in 1903 and was appointed traveling auditor in 1907, becoming auditor of disbursements in 1917, being promoted to the position of assistant general auditor in the same year.

GODFREY ISAACS, head of the Marconi Wireless Telegraph Co., Ltd., London, Eng., arrived in New York City Nov. 20 for a conference with officials of the Radio Corp. of America and representatives of the French Marine & Colonial Wireless Telegraph Co., relative to further working agreements between the different interests.

J. E. MCCLERMON, president of the Northwestern Electric Equipment Co., New York City, electrical supply jobber, has severed his connection with the company in order to devote his entire time to personal interests in the West.

WILLIAM R. ABBOTT, who has held the position of general manager of the Chicago Telephone Co., Chicago, for several years, has been elected a vice-president and one of the directors of the company. He began his telephone career in 1889, when he became cashier of the Westchester (N. Y.) Telephone Co., joining the Chicago Telephone Co.'s organization in 1893. He has occupied successively the positions of chief clerk to the general superintendent, special agent in charge of rights-of-way and claims, superintendent of suburban division, general commercial superintendent and general manager. Mr. Abbott will continue as general manager of the company.

JAMES R. CRAVATH, of the firm of Fowle & Cravath, consulting engineers, Chicago, was tendered a dinner at the Hamilton Club, Chicago. Nov. 30, in anticipation of his contemplated departure for California. About 20 engineers, all old friends of Mr. Cravath, and most of them members of the Chicago Section of the Illuminating Engineering Society, gave the farewell dinner. Mr. Cravath has been a resident of Chicago since 1892, being connected until 1910 in an editorial capacity with publications in the street-railway and central-station fields. In 1910 he established himself as consulting engineer, serving many companies and municipalities in connection with street-lighting plans, public utility rates and appraisals, and power-plant economies. He is perhaps best known through his prominence in the illuminating engineering field, having done considerable original work and contributed extensively to the literature on that subject. His activities in the Western Society of Engineers and the Illuminating Engineering Society have made him a well-known figure among engineers in the Chicago district. The firm of Fowle & Cravath will be dissolved, Mr. Cravath intending to remove to Berkeley, Cal., during this month.

OBITUARY.

JAMES J. REYNOLDS, consulting engineer for the Elgin, Joliet & Eastern Railway Co., died Nov. 28 at his home at 4926 North Rockwell street, Chicago. He was born in Cincinnati in 1850 and came to Chicago in 1885. Mr. Reynolds was nationally known as a railroad builder and was one of the three engineers who supervised the building of the municipal pier in Chicago. and over 20 years ago, as engineer for the New York Central railroad, he built the Chicago, Illinois & Southern railroad. He was a member of the Western Society of Engineers.

BUSINESS OPPORTUNITIES

News of Electrical Construction Projects in All Parts of the Country, Proposals Invited, Foreign Trade Openings and New Companies

EASTERN STATES.

Bar Harbor, Me. — The United States government, public works office, has had plans prepared for the erection of an addition to its local radio station.

Charlestown, Mass.—The Charlestown Gas & Electric Co., has awarded a contract to W. M. Bailey, 88 Broad street, Boston, for the erection of one-story, brick, steel and reinforced-concrete substation, about 40 by 50 ft.

Pittsfield, Mass. — The Pittsfield Electric Co. has been granted permission by the Department of Public Utilities to issue bonds for $125,000, the proceeds to be used for extensions and improvements in its electric power plant and system.

Southbridge, Mass.—The Webster & Southbridge Gas & Electric Co. has been granted permission by the Department of Public Utilities to issue $200,000 in capital stock, the proceeds to be used for extensions, general financing, etc.

Springfield, Mass.—The Diamond Match Co., 111 Broadway, New York City, has awarded a contract to the Turner Construction Co., 178 Tremont street, Boston, for the erection of a two-story electric power plant, 76 by 81 ft., at its works on Howes street, Springfield, to cost about $110,000, including equipment.

Wakefield, Mass.—Under the jurisdiction of the town council a series of public meetings are being held to determine whether the municipal electric plant should be continued in operation as heretofore, or sold to the Malden & Melrose Lighting Co., which is understood to have tendered an offer for the plant.

Hartford, Conn.—A building permit has been issued to the Hartford Electric Light Co. for the erection of its proposed steam-operated electric generating plant, to be located in the vicinity of Van Dyke and Wawarme avenues, near the Connecticut river. The plant will be four stories, 200 by 320 ft., and is estimated to cost $2,815,000.

New Haven, Conn.—The United Illuminating Co. has completed plans for the erection of its proposed power-house addition, 40 by 60 ft., and will inaugurate construction at an early date. Westcott & Mapes, Inc., New Haven, is engineer.

Stamford, Conn.—The Stamford Gas & Electric Co. is completing extensions and improvements in its system, to cost about $70,000, for improved service.

East Providence, R. I.—The Providence Ice Co. has filed plans for the erection of a power house in the vicinity of Roger Williams avenue, to be used in connection with its plant at this location.

Newport, R. I.—The United States government, public works office, has had plans prepared for extensions to the radio plant at Prices Neck, Newport.

Brooklyn, N. Y.—The Kings County Lighting Co., 4802 North Utrecht avenue, has made application to the Public Service Commission for permisison to issue stock to the amount of $2,000,000, the proceeds to be used for proposed extensions and improvements. Ralph Elsman is president.

New York, N. Y.—The Western Union Telegraph Co. is perfecting plans for the installation of its proposed direct cable line between the United States and Germany.

New York, N. Y.—The Department of Public Welfare, Municipal building, has filed plans for the erection of a power-house at the Sea View Hospital, West Brighton, S. I., to cost about $42,000.

New York, N. Y.—In connection with extensions and improvements in its plant at Alsen, N. Y., the Alsen Cement Co. of America, Inc., 112 West 42d Street, New York City, will electrify the entire plant. A contract has been made with the Upper Hudson Electric Corp. for furnishing service to an amount of 500 kw.

Niagara Falls, N. Y.—The Niagara Development Co. has been merged with the Niagara Falls Power Co., under the latter name.

Atlantic City, N. J.—The Atlantic City Electric Co. has received permission from the Board of Public Utility Commissioners to issue preferred stock to an amount of $182,900, to be used for general betterments, financing, etc.

Camden, N. J.—The Victor Talking Machine Co., Front and Cooper Streets, has commenced the erection of the superstructure for its electric power plant, estimated to cost $350,000, including equipment.

Newark, N. J.—The board of education of the Essex County Vocational Schools, Essex building, is taking bids up to Dec. 8 for electrical equipment to be installed in the girls' vocational school, Franklin street, Bloomfield, N. J.

Newark, N. J.—The Public Service Electric Co., has been granted permission by the Board of Public Utility Commissioners to make a trust agreement with the Standard Steel Car Co. for the purchase of coal cars for hauling fuel direct from the mines to the generating plants. Equipment certificates will be issued for $1,300,000 to cover the cost of the cars.

South Amboy, N. J.—The Monmouth Lighting Co., Freehold, will make a number of extensions and improvements in the local street-lighting system.

Harrisburg, Pa. — The Harrisburg Light & Power Co. has made a connection between its lines and the service lines from the power plant of the Bethlehem Steel Co., for increased power supply for local distribution.

Liverpool, Pa.—The Liverpool Electric Co. has completed the construction of a high-tension line to Middleburg for service in that section. The line will be placed in use at once.

Pittsburgh, Pa.—The Duquesne Light Co. is completing negotiations with the budget committee of the city council for the purchase of the municipal power plant in the Northside district for a consideration of $378,651.93.

Pittsburgh, Pa.—The budget committee of the city council has approved an appropriation of $10,000 to be used for the completion of the improved lighting system at the Northside market.

Annapolis, Md.—The Navy Department, Bureau of Yards and Docks, has taken bids for the erection of a power house at the local navy yard.

Cambridge, Md. — The Eastern Shore Gas & Electric Co. will install considerable new machinery at its local power plant for improved and increased service. The company has recently been ordered by the Public Service Commission to make improvements. Service is furnished to Cambridge, Salisbury, Benton and Federalsburg, and line betterments in these districts will be made.

Rising Sun, Md.—The Northern Electric Co. established local light and power service on Nov. 17. Electric energy at high tension is secured from the plant of the Pennsylvania Water & Power Co., and stepped-down by the Northern company for distribution at Port Deposit, Oxford and Rising Sun. It is proposed to extend the system to other communities in this district.

Washington, D. C.—Specifications for the radiotelegraph stations to be installed in different parts of the Mexican Republic have been submitted by Trade Commissioner Cuningham, a copy of which may be obtained from the Bureau of Foreign and Domestic Commerce upon reference to file No. 43,191. These specifications show the desired kilowatts of power for waves of varying meters, the height of tower, type of motor, etc., and other equipment required.

Beechbottom, W. Va.—The West Penn Power Co., Hartje building, Pittsburgh, has awarded a contract to the Austin Co., Union building, Pittsburgh, for the construction of a one-story power house at its plant at Beechbottom, near Wellsburg, to cost about $45,000.

Kinston, N. C.—The city council has approved completed plans for the erection of a municipal power station with auxiliary plant for pumping service. Bids for erection and equipment will be asked at once. The extension will allow for increased ca-

pacity in the present municipal electric plant. Joseph Dawson is mayor.

Mortimer, N. C.—The erection of power house, dams, transmission lines, etc., for the operation of a cotton mill and for public service in Mortimer, is being contemplated by the United Mills Co., Hickory, of which H. J. Holbrook is secretary.

Pinetops, N. C.—The borough council has arranged for a bond issue of $25,000 for the installation of a new light and power system.

Atlanta, Ga.—The Georgia Railway & Power Co., of which Preston Arkwright is president, has applied for permission to issue $650,000 in bonds.

La Grange, Ga.—The city council has approved a bond issue for $20,000 for extensions and improvements in the municipal electric lighting system. S. H. Dunson is mayor.

Manchester, Ga.—The city will expend $10,000 on improvements and extensions to its present electric lighting system.

Pensacola, Fla. — Hydroelectric plants will be built on the Perdide and Blackwater rivers by Reed Bingham.

NORTH CENTRAL STATES.

Carey, O.—The National Lime & Cement Co. plans to construct a power house at this place.

Sandusky, O.—The Sandusky Gas & Electric Co. has installed a 5000-kw. Westinghouse turbine at its plant.

Uhrichsville, O.—The power plant of the Unitile Co. was recently damaged by fire to the extent of $10,000.

West Carrollton, O.—The Dayton Power & Light Co. is contemplating installing a new street-lighting system.

Willoughby, O.—The erection of a factory and power plant to cost about $300,000, is being contemplated by the Thor Tire & Rubber Co. R. C. Gary, 802 Society for Savings building, Cleveland, has charge of the plans.

Wooster, O.—The Wooster Electric Co. has been granted authority to issue capital stock in the sum of $5000 with 6 per cent accumulative preferred capital stock in the sum of $75,000, the proceeds to be used to pay promissory notes amounting to $20,000 and to reimburse the treasury for money paid out for additions and betterments.

Marion, Mich.—Plans have been prepared for a power plant on the Clam river by Burd & Griffels, engineers, Grand Rapids, for the Winterfield Light & Power Co., which will supply current for Marion, Evart, Lake City and Harrison. The dam will be about 22 ft. high and will flood about 500 acres of land.

Portland, Mich.—The citizens will vote Dec. 13 on the question of purchasing an auxiliary oil or steam engine to furnish electric power.

Indianapolis, Ind.—The Indianapolis Street Railway Co. will spend $2,000,000 on improvements to its system.

Newburg, Ind.—The Newburg Light & Water Co. has increased its capital stock from $20,000 to $50,000.

Bloomington, Ill.—The new building of the Union Gas & Electric Co. on West Washington street has been made ready for occupancy. Two new 150-hp. boilers have been installed and there is room for a third.

Danville, Ill. — E. H. Whitham, banker of Rankin, Ill., has been made receiver for the Rankin Electric Light Co., and will operate the plant.

Freeburg, Ill.—Mayor Reinheimer has two propositions before the village board; to buy energy from a transmission line, or to enlarge or rebuild the municipal plant to meet the requirements of a 24-hour service.

Hillsboro, Ill.—The Southern Illinois Light & Power Co. has applied for authority to issue first mortgage 6 per cent gold bonds to the amount of $1,033,880 and 6 per cent cumulative preferred stock to the amount of $480,246.

Matherville, Ill.—The Illinois Public Utilities Commission has authorized the sale of the plant of the Matherville Light & Power Co. to the Sherrard Electric Light and Power Co., Sherrard, Ill.

Eau Claire, Wis.—The Wisconsin-Minnesota Light & Power Co. contemplates spending $500,000 during the coming year on the enlargement of its steam-generating plant at La-Crosse, Wis. Address F. G. Felton, manager, LaCrosse.

Fennimore, Wis.—The Fennimore Prairie Electric & Power Co. has been incorporated with a capital of $25,000, the incorporators being Emil Schwer, R. M. Orchard and Anton Eisele.

Pineville, Mo.—The Ozark Electric & Manufacturing Co. has been formed here to develop the water power of the Rosserman mill and dam. C. D. Resler is president; P. L. Carnel, vice-president; A. York, secretary, and Jasper Strong, treasurer.

St. Louis, Mo.—The United Railways Co. has arranged for an issue of certificates for $4,200,000, the proceeds to be used for extensions, betterments and general operation. Rolla Wells is receiver in charge of the property.

Wellington, Mo.—A municipal electric light plant to cost about $60,000 will be erected. L. A. Walton is city clerk.

Brewster, Kan.—A special election has been called by the city council to vote on the issuance of bonds for the erection of an electric light plant.

Pleasanton, Kan.—Proposals were received by the city clerk Nov. 22 for the building of an electric light plant under one general contract, consisting of the building, two boilers, 250 hp. Uniflow steam engine direct connected to a 200-kv-a. generator, switchboard, condenser, spray pond, etc.

Linwood, Neb.—For the erection of an electric power plant, the village officials are contemplating a bond issue.

Norfolk, Neb.—A bond issue in the sum of $300,000 is being contemplated for the erection of a municipal electric light and gas plant.

Rapid City, S. D.—For the purpose of furnishing power to its quarry operations, the Paving Granite Quarry Co. plans to erect a transmission line one mile long in the Black Hills National Forest Reserve. The necessary license has been applied for from the Federal Power Commission.

Kloten, N. D.—The Kloten Electric Light Co. has been incorporated with a capital of $6000. Charles Colson is interested.

SOUTH CENTRAL STATES.

Bloomfield, Ky.—The Bloomfield light plant has been purchased by the Thor Tire & Rubber Co., of which Harry Peet, Jr., is the proprietor. The present direct-current system will be changed to alternating current.

Taylorville, Ky.—Plans have been prepared for the erection of a municipal electric light plant.

Nashville, Tenn.—Plans have been prepared by G. B. Howard & Co., engineer, 148 Fourth avenue, for improvement to the power plant of the Nashville Industrial Corp. H. G. Hill is president.

Oneida, Tenn.—Bonds in the sum of $15,000 have been voted for an electric plant. Address the mayor.

Florence, Ala.—The United States Engineer Office will receive bids until Dec. 15 for furnishing and delivering one hydraulic turbine of 1000-hp. capacity, with governor and appurtenances.

Mobile, Ala.—Electric traveling cranes, electrical machinery and mechanical hoisting and conveying apparatus will be installed by the Alabama Harbor Commission, Montgomery, at its proposed new coal and ore terminal on the water front, Blakely Island, Mobile. Murray Brown is president.

McComb, Mass.—The city council has called a special election Dec. 6 to vote bonds for $200,000, the fund to be used for the erection of a municipal electrical light and power plant.

Belcher, La.—The borough council is planning for the rebuilding of the municipal electric lighting plant, destroyed by fire Nov. 15.

New Orleans, La.—Bids will be received on Dec. 14 by the supervisor of purchases, board of commissioners, port of New Orleans, 1 Canal street, for the furnishing of rubber-covered, weather-proof and bare copper wires for the board's coal-handling plant.

Hindsville, Ark.—Plans have been completed for the installation of a street-lighting system at this place.

Houston, Tex.—The Houston, Bay Shore & Texas Traction Co. plans to construct an interurban electric railway down the Bay Shore from Houston to Texas City, a distance of about 45 miles. The funds for this work are to be provided by an increase in the capital stock of the company from $300,000 to $1,000,000. Address E. Kennedy, president of the company.

Winnsboro, Tex.—The Winnsboro Ice & Light Co., recently organized, is planning the operation of a local electric system for general commercial light and power service. R. C. Campbell is head.

WESTERN STATES.

Clyde Park, Mont.—The Montana Power Co. will build a transmission line to supply light and power to Shields Valley. J. R. Kaisermah, Livingston, Mont., is the manager.

Idaho Falls, Ida.—The Howard Pulp & Paper Co. has plans under way for the erection of a power plant

to generate 18,000-hp. Thomas L. Tomlines, City Bank building, Syracuse, N. Y., is engineer.

Wallace, Ida.—The Amazon Dixie Mining Co. plans to construct a transmission line over the Lolo National Forest in Montana for mining operations of the company. The necessary license has been applied for from the Federal Power Commission.

Salt Lake City, Utah.—S. Q. Cannon, city engineer, is receiving bids for extensions to the ornamental street-lighting system in the business section.

Casa Grande, Ariz.—Improvements in the light and water departments, including the installation of a steam plant with generators, motors, boilers, etc., are being contemplated by the city council.

Ilwaco, Wash.—The North Shore Light & Power Co. will install a 1000-kw. generator plant and purify its distributing system. George Hibbert, engineer, Astoria, Ore., has prepared the plans.

Seattle, Wash.—Bonds in the sum of $175,000 have been voted by the city council for the Skagit river power project, which will be utilized in rushing the construction of the temporary power plant near Newhalem creek. C. F. Uhden is the engineer.

Seattle, Wash.—A petition has been submitted to the King County Commissioners by the Pacific Coast Coal Co., for permission to erect poles and wires for a 13,000-volt electric transmission line from its Hyde mines to its Black Diamond mines.

Tacoma, Wash.—The city council has passed an ordinance authorizing the commissioner of light and water to spend $30,000 for electric meters and as much more for electric ranges. Ira S. Davidson is in charge of the plans.

Juneau, Alaska.—An application for a power project including the diversion of water from a stream and lake at the head of the William Henry bay, has been filed by the Alaska Endicott Mining & Milling Co. John B. Marshall is in charge.

CANADA.

Toronto, Ont.—The construction of a radial railway line to the border between the United States and Canada is being considered by the Ontario Hydroelectric Power Commission. F. A. Gaby is chief engineer.

Grand Falls, N. B.—The development of water power at this location is being considered by the International Paper Co., Three Rivers, Que.

Winnipeg, Man.—An issue of preferred stock for expenditures on plant and for extensions, is being planned by the Winnipeg Electric Co.

Wolfville, N. S.—The Gaspereaux River Light, Heat & Power Co., Ltd., has been organized with the following officers: President, C. H. Wright; vice-president, Mrs. A. L. Wright; secretary-treasurer, R. A. Jodfrey.

Rossland, B. C.—The West Kootenay Power & Light Co., Ltd., has placed in operation its new power line between Greenwood and Copper mountain. This extension consists of a single 110,000-volt transmission line, the distance between the two points being 108 miles.

Stave Falls, B. C.—To allow for the installation of a 13,000-hp. electrical unit at the Western Canada Power Co.'s power house, plans are under way to raise the level of the storage dam. The cost of this project is estimated at $200,000.

FOREIGN TRADE.

[Addresses of firms referred to in these trade opportunities may be obtained by writing to the Bureau of Foreign and Domestic Commerce, Washington, D. C., or its branch and local co-operative offices. Request for each opportunity should be on a separate sheet and the file number given.]

Motors and Accessories (33,965)—A commercial agent in Serbia proposes to organize a trade bureau for the Balkans and to later open branches in Zagreb, Sofia, Bucharest and Piraeus, and maintain industrial exhibits and a warehouse for the promotion of the sale of American products, such as electric motors and accessories, etc. Reference.

Electrical Appliances, etc. (33,966)—A commercial representative in Australia desires to purchase or secure an agency for the sale of electrical household devices and motor accessories. Quotations should be given f. o. b. New York, San Francisco, or Vancouver. Payment to be cash against documents on arrival of shipment. Reference.

Electric Fixtures (33,980).—An importing firm in Switzerland wishes to be placed in communication with manufacturers of porcelain electric fixtures, especially insulators, with a view to establishing trade relations. Reference.

Electrical Plants (33,994)—A mill owners' association in India desires to secure an agency and purchase electrical plants for bungalows and factories. Quotations should be given c. i. f. Madras. Payment to be made against documents through a bank in India. Reference.

Radio Equipment, etc. (34,003)—An official of the Uruguayan government desires to obtain equipment for use in undertaking an airplane trip, such as a radio telephone and telegraph set, a camera set and two electric heater suits No. 38. An answer by cable is requested, giving the price and weight of suitable articles.

INCORPORATIONS.

Tulsa, Okla.—Isko Electric Co. Capital, $100,000. Incorporators: R. H. Hardin, Edgar A. DeNeules and E. R. Kemp.

Mercedes, Tex.—Electric Supply Co. Capital, $10,000. To deal in electrical supplies. Incorporators: J. H. Jacobson and others.

Olean N. Y.—Allen Electric Sales Corp. Capital, $60,000. To engage in electrical contracting. Incorporators: E. H. Allen, F. H. Higgins and J. E. Duffey.

Maysville, Ky.—Instanto Electric Co. Capital, $25,000. To manufacture electrical devices. Incorporators: E. H. Knapp, Clement Finch and Andrew Clooney.

New Britain, Conn.—Cowles Electric Co. Capital, $25,000. To manufacture electrical products. Incorporators: C. W. Cowles, W. B. Cowles and F. J. C. Ensworth.

Newark, N. J.—Perfection Electric Equipment Co. Capital, $50,000. To manufacture electrical apparatus. Incorporators: C. F. and Edward C. Daniels, and C. Densel.

Atlanta, Ga.—The F. V. L. Smith Battery Co. Capital, $300,000. To manufacture electric batteries. Incorporators: F. V. L. Smith, L. W. Moore and S. L. Manson.

Boston, Mass.—A. J. Felz Co. Capital, $5000. To manufacture electrical equipment and supplies. Incorporators: S. Felz, Hyde Park; E. M. Dangel and Morris Linsky.

Buffalo, N. Y.—Sells, Warren & Sells, Inc. Capital, $10,000. To manufacture electric fixtures and other electrical specialties. Incorporators: H. G. and J. M. Sells, and H. H. Warren.

Moline, Ill.—The R. & V. Motor Co. Capital, $6,500,000. To manufacture motors and appliances. Incorporators: Charles J. Horn, Harry R. Phillips, Frank B. Black and Pam V. Hardy.

New York, N. Y.—J. E. Stearns Industrial Electrical Engineering Corp. Capital, $10,000. To operate as electrical engineers. Incorporators: C. E. Hilex, F. Hartman, and J. E. Stearns, Richmond, L. I.

Toronto, Can.—Nitro Electric Co., Ltd. Capital, $40,000. To manufacture electric fixtures, motors, etc. Incorporators: Ernest V. McKague, Robert D. Hume and Frank Bott, 156 Yonge street, Toronto, Ont.

New York, N. Y.—Electric Regulator Manufacturing Corp. Capital, $100,000. To manufacture electric controlling devices. Incorporators: M. Samburg, J. G. Hochman and A. M. Levy, 195 Chrystie street.

Brockton, Mass.—Wave Electric Co. Capital, $100,000. To manufacture electrical products. Incorporators: Chester F. Hatch, Bridgewater; Arthur G. Cole and Herman Dewhurst, East Bridgewater, Mass.

Providence, R. I.—General Research Corp. Capital, $300,000. To manufacture electrical specialties. Incorporators: Patrick P. Curran, Henry C. Hart and Karl Farkas, 147 Wheeler avenue, Cranston, R. I.

East St. Louis, Ill.—E. A. Koeneman Electric Co. Capital, $20,000. To manufacture electrical devices, etc. Incorporators: Charles C. Koeneman, C. H. Chapline and Albert G. Ziesk, 214 Collinsville avenue, East St. Louis.

Louisville, Ky.—Electrical Appliance Co. Capital, $25,000. To manufacture electrical appliances and equipment. Incorporators: J. T. Noe, Louisville; B. C. Wilson, Frankfort, Ky.; and Henry C. Anderson, Lexinton, Ky.

Toronto, Ont.—Mack Storage Battery Co. of Canada, Ltd. Capital, $100,000. To manufacture storage batteries, electrical machinery, etc. Incorporators: G. W. Adams, 632 Bank of Hamilton building, Toronto; P. E. F. Smiley and others.

FINANCIAL NEWS

Comment on the Financial Outlook in the Electrical Industry, New Securities, Reports of Earnings, Dividends and Utility Stocks

Hurley Machine Co. Earnings.

The Hurley Machine Co. in the ten months ended Oct. 31 last, reports an increase of almost 100% in its net earnings. Net, before federal taxes for that period, amounted to $1,123,220, against $649,098 for the corresponding period of 1919. The October net was $27,659.

Bond Offering of Missouri Utilities Co.

The Chicago Trust Co. is offering an issue of $250,000 Missouri Utilities Co. first mortgage 8% series "A" gold bonds, dated Nov. 1, 1920, and due Nov. 1, 1920, at 100 and interest, yielding 8%. The company operates under the direct supervision of the Public Service Commission of Missouri and in communities where its future growth is assured.

Cincinnati Gas & Electric Co. Bonds to Be Sold.

The stockholders of the Cincinnati Gas & Electric Co. have been asked to approve a $50,000,000 bond issue to be sold as needed. It is planned to retire $4,500,000 notes and $12,000,000 bonds outstanding and provide $5,000,000 for the installation of a fourth generating unit. The balance for future expansion bonds will run for 40 years, the rate of interest to be fixed later.

Wants Authority to Issue Preferred Stock.

The Kansas City Light & Power Co. has filed an application with the Missouri Public Utilities Commission asking for authority to issue $4,000,000 of preferred stock, bearing 8% interest, and $14,977,300 of first mortgage bonds. The capital stock and bonded debt of the company is given at $17,268,000 and its liabilities at $5,245,000. The assets of the company are placed at $31,147,597. When the company was organized it took over the old lighting companies, and the issue of $4,000,000 of preferred stock is sought for the purpose of taking up notes due Jan. 1, 1921.

New Issue of Consolidated Utilities Co.

Counselman & Co., Chicago, is offering a new issue of Consolidated Utilities Co. five-year 8% collateral trust gold notes, dated Oct. 1, 1920, and due Oct. 1, 1925, at 98 and interest to yield 8.5%. The company owns and controls, through stock ownership, the Kansas Electric Utilities Co., the Union City Electric Co., the Miami Valley Electric Co. and the United Electric Co., serving exclusively electric light and power to 20 cities and adjacent territory in Kansas, Indiana, Ohio and Pennsylvania, the total population served being approximately 115,000. The proceeds of this issue are to be used to pay the cost of extensions and betterments in the present service. As a result of the normal growth of the company's business and the additional earnings derived from improvements and extensions now being made with the proceeds of this note issue, it is estimated that the net earnings for the year ending Oct. 31, 1921, will be not less than $200,000. Surplus earnings are approximately seven times the annual interest on this issue. The earnings of the subsidiaries of the Consolidated Utilities Co. for the years ending June 30, 1919, and June 30, 1920, are as follows:

	1920.	1919.
Gross earnings from operations	$690,877.77	$566,037.79
Operating expenses and taxes	470,670.43	386,734.49
Net earnings from operations	220,207.34	179,303.30
Total interest charges	81,341.65	81,109.23
Surplus earnings	138,865.69	98,194.07
Annual interest charge on $250,000 8% notes (this issue)	20,000.00	.....

Time Extended for Deposit of Bonds.

The bondholders' protective committee of the National Properties Co. 4 and 6% bonds has extended until Dec. 11, the time for deposit of the bonds. All deposits up to that time will carry the privilege of participation in the plan of refinancing adopted by the committee.

Cities Service Co.

The earnings for October and the ten months ended Oct. 31 last compare as follows:

	1920.	1919.
Gross earnings	$1,979,787	$1,498,674
Net earnings	1,926,589	1,440,895
Surplus after preferred dividends	1,363,225	923,793
For the ten months ended Oct. 31—		
Gross earnings	20,929,316	16,606,847
Net earnings	20,350,885	16,014,813
Surplus after preferred dividends	14,850,038	10,933,487

Standard Gas & Electric Co.'s Subsidiary.

	1920.	1919.
September gross	$2,573,369	$2,061,427
Net earnings	764,025	711,100
Twelve months' gross	30,809,761	26,268,477
Net earnings	10,960,944	9,667,933

Detroit Edison Co. and Subsidiaries.

	1920.	1919.
October gross	$2,009,547	$1,539,272
Net earnings	460,450	356,802
Surplus after charges	224,712	208,254
Ten months' gross	17,483,765	13,130,801
Net earnings	3,228,923	3,355,515
Surplus after charges	1,262,915	1,947,685

Columbia Gas & Electric Co.

	1920.	1919.
October gross	$1,213,000	$ 939,758
Net after taxes	572,065	426,687
Surplus after charges	366,773	192,035
Ten months gross	11,801,016	9,525,603
Net after taxes	5,863,618	4,641,887
Surplus after charges	3,870,288	2,427,709

Louisville Gas & Electric Co. and Subsidiaries.

Net earnings of the Louisville Gas & Electric Co. and subsidiaries for the year ended Oct. 31 were 15.6% greater than for the corresponding previous year. The figures are reported as follows:

Month of October.	1920.	1919.
Gross earnings	$ 368,823	$ 287,552
Net earnings	163,085	143,470
Twelve months.		
Gross earnings	4,294,729	3,486,318
Net earnings	2,051,021	1,773,563

Dayton Power & Light Co.

October gross	$ 325,092	$ 259,177
Net after taxes	70,522	83,565
Total income	70,965	87,385
Surplus after charges	27,770	22 498
Balance after preferred dividends	10,341	5,897

Havana Electric Railway, Light & Power Co.

	1920.	1919.
September gross	$ 961,934	$ 792,317
Net earnings	424,903	401,597
Total income	437,518	409,848
Surplus after fixed charges	259,134	240,607
Nine months' gross	8,312,325	6,724,847
Net earnings	4,039,492	3,402,231
Total income	4,124,287	3,481,841
Surplus after fixed charges	2,438,719	1,798,796

Dividends.

	Term.	Rate.	Payable.
Am. Pub. Service pfd.	Q	1.75%	Jan. 3
Ark. Val. Ry. L. & P. pfd.	Q	1.75%	Dec. 15
Buff. Gen. El. com.	Q	2%	Dec. 31
Conn. Power Co. pfd.	Q	$1.50	Dec. 1
Eastern Wis. El. pfd.	Q	1.75%	Dec. 1
El Paso El. com.	Q	2.50%	Dec. 15
Montana Power com.	Q	.75%	Jan. 2
Montana Power pfd.	Q	1.75%	Jan. 2
Penn. Water & Pr.	Q	1.75%	Jan. 1
Puget S. Gas & El. pfd.	Q	1.75%	Dec. 15
Standard Gas & El. pfd.	Q	2%	Dec. 15
Wis.-Minn. Lt. & Pr. pfd.	Q	1.75%	Dec. 1

WEEKLY COMPARISONS OF CLOSING-BID PRICES OF SECURITIES OF LEADING ELECTRICAL COMPANIES.

Quotations furnished by F. M. Zeijler & Co., Rookery Bldg., Chicago.

Public Utilities—	Div. rate. Per cent.	Bid Nov. 23.	Bid Nov. 30.
Adirondack Electric Power of Glens Falls, common	6	13½	13
Adirondack Electric Power of Glens Falls, preferred	6	71	73
American Gas & Electric of New York, common	..	97	100
American Gas & Electric of New York, preferred	6	36	35½
American Light & Traction of New York, common	..	105	105
American Light & Traction of New York, preferred	6	79	79
American Power & Light of New York, common	4	53	48
American Power & Light of New York, preferred	6	62	61
American Public Utilities of Grand Rapids, common	..	5	6
American Public Utilities of Grand Rapids, preferred	7	16	19
American Telephone & Telegraph of New York	..	99½	..
American Water Works & Elec. of New York, common	..	2½	2½
American Water Works & Elec. of New York, particip	7	5	5
American Water Works & Elec. of New York, 1st preferred	..	43	42
Appalachian Power, common	..	3	2
Appalachian Power, preferred	7	16	15
Cities Service of New York, common	+extra	285	270
Cities Service of New York, preferred	6	64½	64
Commonwealth Edison of Chicago	8	102	102
Comm. Power, Railway & Light of Jackson, common	..	14	13
Comm. Power, Railway & Light of Jackson, preferred	6	36	34
Federal Light & Traction of New York, common	..	7	7
Federal Light & Traction of New York, preferred	..	47	46
Northern States Power of Chicago, common	..	40	41
Northern States Power of Chicago, preferred	ex.div.	76	77
Pacific Gas & Electric of San Francisco, common	..	48	48½
Public Service of Northern Illinois, Chicago, common	7	63	62
Public Service of Northern Illinois, Chicago, preferred	6	83	82
Standard Gas & Electric of Chicago, common	..	12	12
Standard Gas & Electric of Chicago, preferred	8	36	35
Tennessee Railway, Light & Power of Chattanooga, common	..	1	½
Tennessee Railway, Light & Power of Chattanooga, preferred	6	3	2½
Western Power of San Francisco, common	..	20	19
Western Union Telegraph of New York	extra	86½	87
Industrials—			
Electric Storage Battery of Philadelphia, common	4	112	100
General Electric of Schenectady	8	122	126
Westinghouse Electric & Mfg. of Pittsburgh, common	7	44	43